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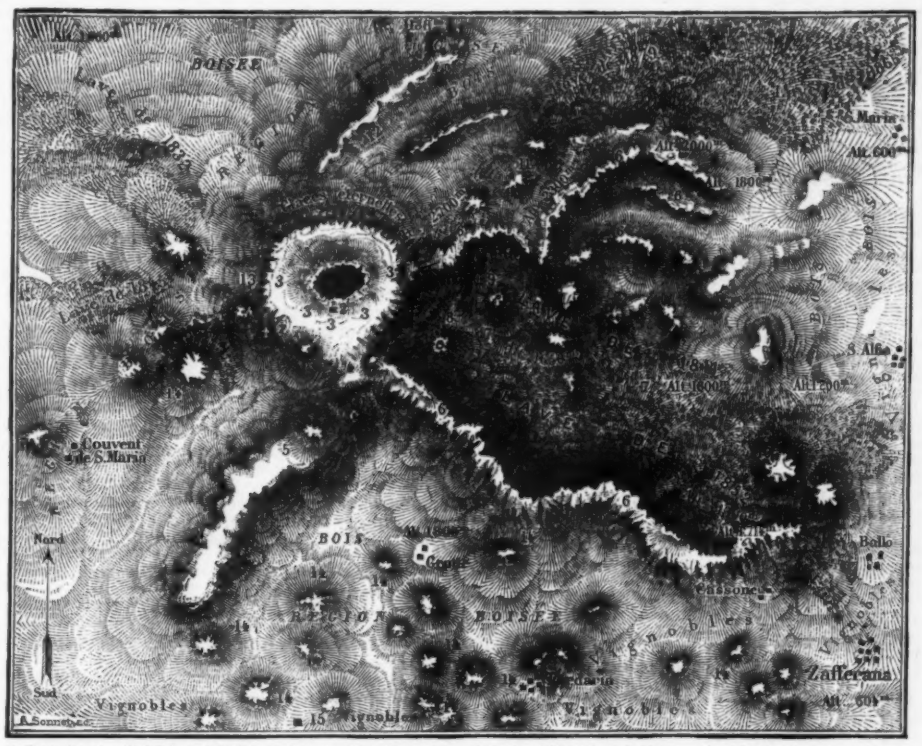
## ERUPTION OF THE VOLCANO OF ETNA.

On Sunday, July 10, an earthquake, followed by an eruption of Mt. Etna, caused considerable damage to the town of Nicolosi, on the south side of the mountain, and eight miles northwest of Catania. The advices show that the stream of molten lava flowing from the volcano increased in width and volume during several days, being near the crater over fifteen yards wide, and at a distance therefrom dividing into two streams. A large area of cultivated land has been laid waste and great destruction has been wrought among the vineyards. The villages of Nicolosi and Belpasso it was thought would doubtless be totally destroyed, and three days after the outbreak over twelve thousand people had left their homes and were encamped in the fields. Vesuvius is now also reported to be unusually active, throwing up lava abundantly.

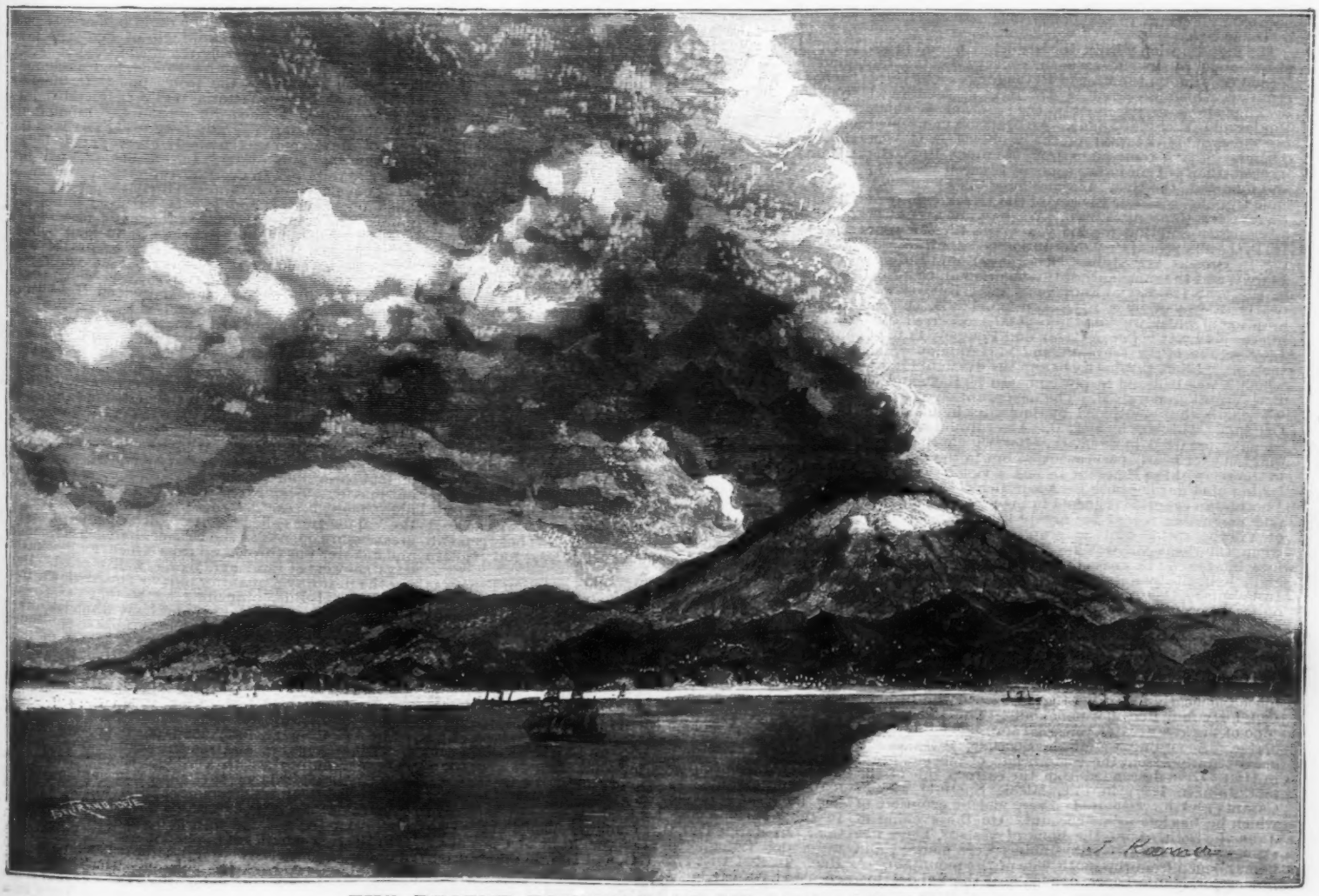
The aspect of Mount Etna and vicinity since its eruption in 1879 is shown in the accompanying illustrations. The lower engraving is from *Le Monde Illustre*, being a design by M. Koerner. Thriving cities, with numerous cupolas, are stretched out at the base of the mountain, and numerous villages, with long-pointed steeples, lie scattered over the lower region.




1. Central crater (16,800 feet altitude). 2. Astronomical observatory. 3. Plain of the Lake. 4. Montagnola (8,660 feet). 5. La Schiena dell' Asino. 6. Rocks bordering the Valle del Bove. 7. Valle del Bove. 8. Eruption craters of 1852. 9. Crater of 1811. 10. Monte di Calanna (4,200 feet). 11. Craters of 1879. 12. Valle del Leone. 13. Other craters of 1879. 14. Ancient craters. 15. Casa dei Bosco.

MAP OF THE UPPER REGIONS OF ETNA.

These form a vast panorama, and terminate at a confused assemblage of conical hills, which formerly were so many craters. Above these we see rising, immense and majestic, the cone of the volcano, which overtops the clouds and forms the highest point of the island. The cultivated zone of Etna extends beyond 3,900 ft. elevation. From this limit vegetation rapidly grows poorer, and, toward an elevation of 6,500 ft. becomes very rare. However, up to the base of the central cone, that is to say, at about 10,000 ft., the vegetable kingdom is still represented by four small plants, whose botanical names are as follows: *Robertsia taraxacoides, Artemisia etnensis, Senecio etnensis,* and *Tanacetum vulgare.* The slope of Etna is very slight up to an elevation of 3,200 to 4,000 ft., and in general makes an angle of only 15 to 20 degrees with the horizon; beyond this it rapidly increases, but at 9,500 ft. the inclination of the ground is suddenly interrupted by a sort of plain covered with black sand. This is the *Piano del lago.* At 1,300 ft. to the north of this plain rises the cone of the central crater, at the foot of which is the astronomical observatory and the *Casa Etnea*, a small hotel designed for travelers who make the ascent of the volcano. The mouth of the crater of Etna is nearly 6,000 ft. in circumference, since it



THE RECENT ERUPTION OF MT. ETNA IN 1892.

was enlarged by about 1,800 ft. at the eruption of 1879. The interior of the crater exhibits the aspect of a large cup filled with scoriæ and lava, among which are interspersed numerous fumaroles. At the bottom of the cup, at a depth of 200 ft., there is seen the aperture of the eruptive channel, which usually has a diameter of about 650 ft.

Mount Etna is situated on a tertiary formation, and is almost entirely composed of volcanic materials. On the eastern side of the mountain is a vast depression known under the name of the *Valle del Bove*, about six and a quarter miles long by three miles wide. Its depth at some localities is more than 3,000 ft., and its sides are surrounded at the north, south, and west by high rocks, several of which exhibit characteristics of aspect that are truly admirable.

Some of these rocks are formed of a very black lava, which well imitates antique serpentine. Others exhibit a color of a dark red, due to the oxidation of ferruginous matter. Moreover, the alteration of the mass of mineral is so advanced that it exhibits a whitish color similar to that of carbonate of lime, and there are also places where the lava is of a characteristic yellow color, which has caused the rocks wherein it is found to be styled *mountains of gold*.

Along with this, the rocky chains which border the Valle del Bove present a greater interest, in that they are almost all composed of several alternating strata of lava intermingled with banks of earthy materials and traversed in all directions by numerous veins of other and more recent lavas, the origin of which can be easily explained. For it is well known that when one of the sides of the mountain bursts to give passage to the incandescent matter, there results usually around the principal fracture other radiating fractures which decrease in size as they are prolonged to varying distances; and the liquid lava then penetrates these secondary fractures, fills them, and seals them upon solidifying. Thus, by examining the position of these strata and veins, there may be constructed a very extended chronology of the old eruptions.

The eruption of 1879 was considered by Prof. Silvestri, in a report made to the Italian government, to have been in a stage of preparation or partially suppressed development for a period of five years. It broke out May 26, there being craters on the north and south sides of the mountain, the latter having eight eruptive mouths, but the stream on the south side of the mountain did but little damage. From the eruption on the north side, by the evening of May 29, the lava had flowed six and one-quarter miles, destroying the bridge of Passo Pisciaro and crossing the postal road between Randazzo and Linguaglossa. After the evening of June 1 the force of the eruption began somewhat to abate, and by June 6 it was practically at an end. The lava stream ran nearly seven miles from its source, and ultimately stopped five hundred yards from the River Alcantara, and about half a mile from the village of Mojo.

At its termination it is 23 ft. in breadth and nearly 32 ft. in height. The lava stream entered the bed of the Pisciaro torrent with a velocity of from four to five meters a second, which was reduced to two meters a minute in the lower valley of less inclination. In seventy-six hours the lava had flowed more than six miles from its source.

*Eruptions.*—A list of all the eruptions of Etna from the earliest times has been given by several writers, notably by Ferrara in his *Descrizione dell' Etna*, and by Gemellaro.

The first eruption within the historical period probably happened in the seventh century B. C.; the second occurred in the time of Pythagoras. The third eruption, which occurred in 477 B. C., is mentioned by Thucydides, and it must be the eruption to which Pindar and Æschylus allude. An eruption mentioned by Thucydides occurred in the year 426 B. C. An outburst of lava took place from Monte di Mojo, the most northerly of the minor cones of Etna, in 396 B. C., and following the river Acesines (now the Alcantara), ended in the sea near the site of the Greek colony of Naxos (now Capo di Schiso). We have no record of any further eruption for 256 years, viz., till the year 140 B. C. Six years later an eruption occurred, according to Orosius and Julius Obsequens; and Fluvius Flaccus and the same authorities mention an eruption in the year 126 B. C. Four years later Katana was nearly destroyed by a new eruption, 122 B. C. An eruption of which we possess no details occurred during the civil war between Cæsar and Pompey, 49 B. C. Livy speaks of an eruption and earthquake which took place (43 B. C.) shortly before the death of Cæsar, which it was believed to portend. In 36 B. C. and 32 B. C., eruptions occurred. The next eruption of which we hear is that mentioned by Suetonius in his life of Caligula. This was in 40 A. D. An eruption is stated to have occurred in 72 A. D., after which Etna was quiescent for nearly two centuries, but in the year 253, in the reign of the Emperor Decius, a violent eruption lasting nine days occurred. According to Carrera and Photius, an eruption occurred in the year 420. We now find no further record for nearly 400 years. Geoffrey of Viterbo states that an eruption occurred in 812, when Charlemagne was in Messina. After another long interval, in this case of more than three centuries and a half, the mountain again entered into eruption. In February, 1169, one of the most disastrous eruptions on record occurred.

A violent earthquake, which was felt as far as Reggio, destroyed Catania, in the course of a few minutes burying 15,000 persons beneath the ruins. It was the vigil of the feast of St. Agatha, and the cathedral of Catania was crowded with people, who were all buried beneath the ruins together with the bishops and forty-four Benedictine monks. The side of the cone of the great crater toward Taormina fell into the crater. According to Micola Speziale, there was a great eruption from the eastern side of the mountain in 1181. Lava descended from the eastern side of the mountain in 1285; in 1329, Micola Speziale was in Catania and he witnessed a very violent eruption, of which he has left us an account. On the evening of June the 28th, about the hour of vespers, Etna was strongly convulsed, terrible noises were emitted and flames issued from the south side of the mountain. A new crater, Monte Lepre, opened near the Val del Bue, above the rock of Musarra, and emitted large quantities of dense black smoke. Soon afterward a torrent of lava poured from the crater, and red hot masses of rock were projected into the air. Four years after the last eruption it is recorded by Silvaggio that a fresh outburst took place. A manuscript preserved in the archives of the cathedral of Catania mentions an eruption which occurred on the 6th of August, 1371, which caused the destruction of numerous olive groves near the city. An eruption which lasted for twelve days commenced in November, 1408. A violent earthquake in 1444 caused the cone of the mountain to fall into the great crater. An eruption of short duration, of which we have no details, occurred in 1447. After this Etna was quiescent for 89 years. Cardinal Bembo and Fazello mention an eruption which occurred toward the close of the fifteenth century. In March, 1536, a quantity of lava issued from the great crater and several new apertures opened near the summit of the mountain and emitted lava. A year later, in May, 1537, a fresh outburst occurred. A number of new mouths were opened on the south slope of the mountain near La Fontanelle, and a quantity of lava was emitted, which flowed in the direction of Catania, destroying a part of Nicolosi and St. Antonio. In four days the lava had run 15 miles. The cone of the great crater suddenly fell in, so as to become level with the Piano del Lago. The height of the mountain was thus diminished by 330 ft. Three new craters opened in November, 1566, on the northeast slope of the mountain. In 1579, 1603, 1607, 1610, 1614, and 1619, unimportant eruptions occurred. In February, 1633, Nicolosi was partially destroyed by a violent earthquake, and in the following December earthquakes became frequent around the mountain. In 1646 a new mouth opened on the northeast side, and five years later several new mouths opened on the west side of the mountain, and poured out vast volumes of lava, which threatened to overwhelm Bronte. We have a more detailed account of the eruption of 1669 than of any previous eruption. It was observed by many men of different nations, and we find accounts of it in the philosophical transactions and in several separate narratives in French and Italian. Perhaps the most accurate and complete description is that given by Alfonso Borelli, professor of mathematics in Catania. The eruption was in every respect one of the most terrible on record. On the 8th of March the sun was obscured and a whirlwind blew over the face of the mountain, at the same time earthquakes were felt and they continued to increase in violence for three days, at the end of which Nicolosi was converted into a heap of ruins. On the morning of the 11th, a fissure nearly 12 miles in length opened in the side of the mountain and extended from the Piano di St. Leo to Monte Frumento, a mile from the summit. The fissure was only 6 ft. wide, but it seemed to be of unknown depth, a bright light proceeding from it. Six mouths opened in a line with the principal fissure and emitted vast volumes of smoke, accompanied by low bellowing, which could be heard 40 miles off. Toward the close of the day a crater opened about a mile below the others and ejected red hot stones to a considerable distance, and afterward sand and ashes, which covered the country for a distance of 60 miles.

The new crater soon vomited a torrent of lava, which presented a front of two miles. It encircled Monpilieri, and afterward flowed toward Belpasso, a town of 8,000 inhabitants, which was speedily destroyed. Seven mouths of fire opened round the new crater and in three days united with it, forming one large crater 800 feet in diameter. The torrent of lava had continued to flow and it destroyed the town of Mascalucia on the 23d of March. On the same day the crater cast up great quantities of sand, ashes, and scoriæ, and formed above itself the great double-coned hill called Monti Rossi, from the red color of the ashes of which it is mainly composed. On the 25th very violent earthquakes occurred and the cone of the great central crater was shaken down into the crater, for the fifth time since the first century A. D. The original current of lava had divided into three streams, one of which destroyed San Pietro, the second Camporotondo, and the third the lands about Mascalucia, and afterward the village of Mistervianco. Fourteen villages were afterward destroyed and the lava made its way toward Catania at Albanello, two miles from the city. It undermined a hill covered with corn fields and carried it forward a considerable distance. A vineyard was also seen to be floating on its fiery surface. When the lava reached the walls of Catania, it accumulated without progression until it rose to the top of the wall, 60 feet in height, and it then fell over in a fiery cascade and overwhelmed a part of the city. Another portion of the same stream threw down 120 feet of the wall, and flowed through the city. On April 23, the lava reached the sea, which it entered as a stream six hundred yards broad and forty feet deep. The stream had moved at the rate of thirteen miles in twenty days, but as it cooled it moved less quickly, and during the last twenty-three days of its course it only moved two miles. On reaching the sea the water of course began to boil violently and clouds of steam arose, carrying with them particles of scoriæ. The volume of lava emitted during this eruption amounted to many millions of cubic feet. Ferrara considers that the length of the stream was at least fifteen miles, while its average width was between two and three miles, so that it covered at least forty square miles of surface.

For a few years after this terrible eruption Etna was quiescent, but in 1682 a new mouth opened on the east side of the mountain and lava issued from it and rushed down the precipices of the Val del Bue. In 1688 a torrent of lava burst from an opening in the great cone, and in the following year lava was emitted from a mouth in the Val del Bue. Early in January, 1693, clouds of black smoke were poured from the great crater and loud noises resembling the discharge of artillery were heard. A violent earthquake succeeded and Catania was shaken to the ground, burying 18,000 of its inhabitants. It is said that in all fifty cities and towns were destroyed in Sicily, together with from 60,000 to 100,000 inhabitants. Lava was emitted from the crater, the cone of which was lowered by the eruption. In the following year Etna again entered into eruption. In March, 1702, three mouths opened in the Contrada del Trifoglietto, near the head of the Val del Bue. In 1723, 1732, 1735, 1744, and 1747, slight eruptions occurred. Early in the year 1755 Etna began to show signs of disturbance; a great column of black smoke issued from the crater, from which forked lightning was frequently emitted. Loud detonations were heard and two streams of lava issued from the crater. A new mouth opened near Rocca di Musarra in the Val del Bue, four miles from the summit, and a quantity of lava was ejected from it. An extraordinary flood of water descended from the Val del Bue, carrying all before it and strewing its path with large blocks. Recupero estimated the volume of water at 16,000,000 cubic feet, probably a greater amount than could be furnished by the sudden melting of all the winter's snow on the mountain. It formed a channel two miles broad, and in some places thirty four feet deep, and it flowed at the rate of a mile in a minute and a half, during the first twelve miles of its course.

Lyell considers that the flood was probably produced by the melting not only of the winter's snow, but also of older layers of ice which were suddenly liquefied by the permeation of hot steam and lava and which had been previously preserved from melting by a deposit of sand and ashes, as in the case of the ancient glacier found near the summit of the mountain in 1828. In November, 1758, a smart shock of earthquake caused the cone of the great crater to fall in, but no eruption occurred at the time. In 1759, 1763, 1766, and 1780 eruptions occurred, and on the 18th of May in 1780 a fissure opened on the southwest side of the mountain and extended from the base of the great crater for seven miles, terminating in a new mouth, from which a stream of lava emanated. This encountered the cone of Palmintelli in its course and separated into two branches, each of which was about 4,000 feet wide. Other mouths opened later in the year, and emitted larger quantities of lava, while in 1781 and 1787 there were slight eruptions. Five years afterward a fresh outburst occurred; earthquakes were prevalent, and vast volumes of smoke were carried out to sea, seeming to form a gigantic bridge between Sicily and Africa. A torrent of lava flowed toward Aderno, and a second flowed into the Val del Bue as far as Zuccolaro. A pit called *La Cisterna*, forty feet in diameter, opened in the Piano del Lago near the great cone, and ejected smoke and masses of old lava saturated with water. Several mouths opened below the crater and the country round about Zaffarana was desolated. In 1797, 1798, 1799, 1800, 1802, 1805, and 1808 slight eruptions occurred. In March, 1809, no less than twenty one mouths of fire opened between the summit of the mountain and Castiglione, and two years afterward more than thirty mouths opened in a line running eastward from the summit for five miles. They ejected jets of fire, accompanied by much smoke. In 1819, five new mouths of fire opened near the scene of the eruption of 1811, three of these united into one large crater, and poured forth a quantity of lava into the Val del Bue. The lava flowed until it reached a nearly perpendicular precipice at the head of the valley of Calanna, over which it fell in a cascade, and being hardened by its descent, it was forced against the sides of the tufaceous rock at the bottom, so as to produce an extraordinary amount of abrasion, accompanied by clouds of dust worn off by the friction. Mr. Scrope observed that the lava flowed at the rate of about a yard an hour, nine months after its emission. Eruptions occurred in 1831, 1832, 1838 and 1842. Near the end of the following year, fifteen mouths of fire opened near the crater of 1832, at a height of 7,000 feet above the sea. They began by discharging scoriæ and sand, and afterward lava, which divided into three streams, the two outer of which soon came to a standstill, while the central stream continued to flow at the rapid rate of 180 feet a minute, the descent being an angle of 25°. The heat at a distance of 120 feet from the current was 90° F. A new crater opened just above Bronte, and discharged lava which threatened the town, but it fortunately encountered Monte Vittoria, and was diverted into another course. While a number of the inhabitants of Bronte were watching the progress of the lava the front of the stream was suddenly blown out as by an explosion of gunpowder. In an instant, red hot masses were hurled in every direction and a cloud of vapor enveloped everything. Thirty-six persons were killed on the spot and twenty survived but a few hours. The great crater showed signs of disturbance by emitting dense volumes of smoke and loud bellowings, also quantities of volcanic dust saturated with hydrochloric acid, which destroyed the vegetation wherever it fell. A very violent eruption, which lasted more than nine months, commenced on the 26th of August, 1852. It was first witnessed by a party of six English tourists who were ascending the mountain from Nicolosi in order to witness the sunrise from the summit. As they approached the Casa Inglesi, the crater commenced to give forth ashes and flames of fire. In a narrow defile they were met by a violent hurricane, which overthrew both the mules and the riders and urged them toward the precipices of Val del Bue. They sheltered themselves beneath some masses of lava, when suddenly an earthquake shook the mountain and the mules in terror fled away. They returned on foot toward daylight to Nicolosi, fortunately without having sustained injury. In the course of the night, many *bocche del fuoco* opened in that part of the Val del Bue called the Balzo di Trifoglietto, and a great fissure opened at the base of Giannicola Grande, and a crater was thrown up from which for seventeen days showers of sand and scoriæ were ejected. During the next day a quantity of lava flowed down into the Val del Bue, branching off so that one stream flowed to the foot of Monte Finocchio, while the other flowed to Monte Calanna. The eruption continued with abated violence during the early months of 1853, and did not fully cease till May 27th. The entire mass of lava ejected is estimated to be equal to an area six miles long by two miles broad, with an average depth of about 12 feet. In October, 1864, frequent shocks of earthquake were felt by the dwellers on Etna. In January, 1865, clouds of smoke were emitted by the great crater, and roaring sounds were heard. On the night of the 30th a violent shock was felt on the northeast side of the mountain and a mouth opened below Monte Frumento, from which lava was ejected. It flowed at a rate of about a mile a day, and ultimately divided into two streams. By March 10th the new mouths of fire had increased to seven in number, and they were all situated along a line stretching down from the summit. The three upper craters gave forth loud detonations three or four times a minute. Since 1865 the mountain has been in a quiescent state.

It will be seen from the foregoing account that there is a great similarity in the general character of the eruptions of Etna. Earthquakes presage the outburst; loud explosions are heard; rifts and *bocche del fuoco* open in the sides of the mountain; smoke, sand, ashes, and scoriæ are discharged. The action localizes itself in one or more craters; cinders are thrown out and accumulate around the crater in a conical form; ultimately lava rises through the new cone, frequently breaking down one side of it where there is least resistance and flowing over the surrounding country. Then the eruption is at an end. Out of the seventy-eight eruptions mentioned above, a comparatively small number have been of extreme violence, while many have been of a slight and harmless character. According to Lyell, Etna is rather older than Vesuvius—perhaps of the same geological age as the Norwich Crag. At Trezza, on the eastern base of the mountain, basaltic rocks occur associated with fossiliferous Pliocene clays. The earliest eruptions of Etna are older than the glacial period in central and northern Europe. If all the minor cones and monticules could be stripped from the mountain, the diminution of bulk would be extremely slight. Lyell concludes that, although no approximation can be given of the age of Etna, "its foundations were laid in the sea in the newer Pliocene period." From the slope of the strata from one central point in the Val del Bue, he further concludes that there once existed a second great crater of permanent eruption.

Such are the principal facts in the history of a volcano justly called *famoso, immenso, terribile*, which has excited the wonder of all nations in all ages of the history of the world.

## HUDSON BAY—CANADA'S GREAT LONE SEA.

By WILLIAM SMITH, Deputy Minister of Marine and Fisheries of Canada.

THE navigation of the waters of Hudson Bay and Straits, as a practicable commercial route for the transport of produce from the Northwest Territories of Canada, is a question that is now creating much attention. The extraordinary increasing yield of the harvest with each succeeding year requires an outlet from that country other than by rail, the facilities of which means of transport are already taxed to their utmost, and now leave on hand in the country large quantities of grain unshipped. A few years ago, the Canadian government equipped an expedition for the purpose of ascertaining the actual condition of the straits during the summer, the length of time available for navigating them, and wintering parties were left at several stations to report on the ice and its movements, open water, tides, climatic conditions, and meteorological data during that season. The result of this was a blue book or two, with an able report from Lieut. A. R. Gordon, R.N., in charge of the expedition, and a geological report from Dr. Bell, of the Geological Survey, who accompanied that expedition. There the matter rested, and since then nothing has been done to utilize the information so obtained. As the waters in question are very little known beyond the small circle of the officials of the Hudson Bay Company, whose ships make annual trips from the Orkneys, with supplies for York Factory and the other forts and posts in the northern wilderness, or by an occasional adventurous skipper of some American whaler, or fishing vessel plying its avocations in the bay, the following sketch may be of interest.

The little that, until quite recently, was known respecting this great northern inland sea of Canada and its surroundings is that, in 1610, Henry or Hendrick Hudson, an English navigator, entered the bay, in his ship the Discoverie, expecting to find the looked-for northwest passage to the China seas, one of the great objects of adventure in that age, and that failing in this, he was cast adrift by his mutinous seamen, in a small boat or pinnace, the fate of which was never ascertained. The waters he had sailed thus became his tomb, and in the name they have since borne, his epitaph. After the occupation of Rupert's Land by the British, it must have been looked upon as a strategic point of importance from the fact of a very large and strong fort having been erected in a commanding position (at the mouth of the Churchill River, where it discharges into the bay), which in its day mounted forty guns. This was surrendered, without firing a shot, to the French Admiral La Perouse in 1772, who spiked the guns, blew up some thirty feet or more of the ramparts, and did other damage, for which the British government presented a nice little bill for France to settle. A number of dismantled guns still lie among the ruins of "Fort Prince of Wales," which Dr. Bell styles "probably the largest ruin in North America."

In 1845, Admiral Sir George Back stated, before a committee of the imperial House of Commons, that if he had anything to convey to Red River (the Winnipeg of to-day), he would unquestionably prefer the route via York Factory. This fact also did not escape the eagle eye of the Duke of Wellington, who, in 1846, placed in Fort Garry, by means of boats on the Nelson River, and subsequent water communication through Lake Manitoba, a detachment of 400 rifles, in less than 30 days from York Factory, where they had been landed. Although in the popular mind Hudson Bay is apt to be associated with the Arctic regions, no part of it lies within the Arctic circle, the latitude of its southern extremity being south of London. An adequate conception of its extent, including James Bay at the south, may be formed from the fact that its total area is some 500,000 square miles, or nearly half that of the Mediterranean Sea; that it measures about 1,000 miles in length, and that it is over 600 miles wide in its northern part. The principal channel is 500 miles long, with an average breadth of 100 miles.

The numerous groups of islands along its eastern shores are surrounded by deep water; the depth over the bay is uniform, averaging 70 fathoms throughout, deepening to 100 or more in approaching the straits, while in the latter it varies in the center from 100 to 300 fathoms, the latter being the deepest sounding. The bottom consists of bowlders, clay and mud. Near the shores a stiff clay, affording good holding ground for anchorage, is almost invariably met with on both sides. The latter are high and rocky, but the northern is less precipitous than the southern. The bay itself is the great central basin of water drainage of the northern part of the continent from the center of the Labrador peninsula on the east to the Rocky Mountain range on the west, while from a point near latitude 45° the waters flow from every direction, and discharge by one great outlet—the Nelson River—into the bay. Dr. Bell asserts that the whole extent of territory drained into Hudson Bay approaches three millions of square miles, over the greater part of which extends a temperate climate, with large tracts of fertile soil. Of the other rivers flowing into the bay, thirty are of considerable size. Those from the east run parallel to each other, being progressively smaller toward the north, a fact due to the height of land in Labrador lying further inland toward the south; on the west coast the Albany and the Churchill are the longest rivers, but the Nelson discharges the largest volume of water in a course of 400 miles, combining as it does the waters of a number of rivers from the south, and it is the only muddy river that enters the bay. The Churchill is beautifully clear, somewhat larger than the Rhine, and with a rocky, deep and comparatively narrow mouth forming a splendid harbor, which can be entered with ease and safety by the largest ships at all stages of the tide, thus offering every advantage for shipping, and its entrance is destined some day to be the main commercial point of this inland sea. The drawbacks to most of the other rivers as harbors are the bars outside. The average rise and fall of the tide on the west coast is from eleven to twelve feet. Few of the rivers afford uninterrupted navigation for large vessels to any great distance from the coast. During the season of high water, shallow draught steamers might ascend the Moose River for upward of 100 miles, Hayes River 140 miles, and the Albany nearly 250 miles, but large steamers might ascend the Nelson River for 70 or 80 miles from the sea.

This Great Lone Sea, situated in the heart of British North America, and actually possessing a seaport in the center, 1,500 miles nearer than Quebec to the fertile lands of the Northwest, begins to possess a new interest to Great Britain, seeing that the future highway to the west may yet pass through it. York Factory, which is actually nearer Liverpool than New York, has been styled by Professor Hind the "Archangel" of the west, but the mouth of the Churchill may more fitly challenge that title. A glance at the map of the northern hemisphere shows the shortest route between the Northwest Territories and England is through Hudson Bay. A close calculation of relative distances, made in the Canadian Department of the Interior, shows Winnipeg, lying at the extreme southeastern portion of these territories, to be at least 800 miles nearer to Liverpool by the Hudson Bay route than by the St. Lawrence, while the difference in favor of the former increases continually as we advance northwesterly into the interior. This saving in distance represents economy in time and money, or in freight and passenger rates. Owing to its cooler and more uniform temperature, this northern route, besides shortening the distance, would afford greater advantages, especially as regards the live stock of the western ranches. And, what is of the greatest importance, an inlet by Hudson Bay is the only thoroughly independent channel which can ever be established between Great Britian and her North American possessions.

Previous to the report of Lieut. Gordon's exploratory expedition, an impression prevailed that on account of ice, navigation for the ordinary purposes of commerce was impossible through the straits. He, however, very plainly sums up his observations as follows: "While I am of opinion there will always be more or less fluctuation in the date of the opening of practical navigation for the purpose of commerce, the shipowner who sends in a freight-carrying steamer before the 15th of July will almost certainly be subjected to such delays as will add very materially to the cost of the voyage. In estimating the period of navigation of an ordinary year, I should say from the 15th of July to the 15th of October, with a possibility of navigation from 1st July to 1st November; and later than the 15th October, the risks of navigation are so increased that the question of insurance would in all probability settle the date."

Lieut. Schwatka, of the United States, who spent two years up in the northwest of Hudson Bay in search of the relics of the Franklin expedition, says: "From my experience, and conversation with navigators who had spent many years therein, I think the straits and bay would be considered navigable for at least two months for sailing craft, and this would probably be more than double for steam. Of course the bay is navigable much earlier and later than the straits, and the above estimate is for the latter." Again, a ship, "strengthened for the ice, might prolong these times considerably, and signal stations on prominent points could also materially assist vessels essaying the passage, by a simple code expressing the condition of the ice."

Much of the ice encountered in the straits consists of the giant bergs brought down by the Arctic current from the Humboldt and other glaciers, and field ice from the Arctic Sea coming down the east Greenland coast, together with all that comes down Davis Straits. The current from the latter flows west along the north shore of the straits, its set probably terminating at the east side of Salisbury Island, whence it takes an easterly course along the south side of the straits. A mass of Arctic ice outside pens up the ice in the straits till the end of June, when it tends southward, and the Hudson Straits ice is then free to pass out, and disappear under the influence of the rising temperature of both air and sea. The tidal currents in the straits flow with great rapidity, especially at the eastern end about the Buttons Islands, and at the western end near the Digges Islands, causing the ice to whirl in every direction. The records of a number of voyages made by the early explorers of the seventeenth century and of a later date all testify to the presence of broken ice during July in the straits, but broken sufficiently to make it safe for working through.

The uncertainties of the tidal currents in these waters, defying the calculations of the navigator, is instanced in the case of Captain Parry's expedition in 1821, with the Fury and the Hecla, when on the 6th July these ships were close together in the ice, and on the following morning the Hecla had drifted eleven miles from her consort, without any breeze. Considerable fog hangs over the bay in the months of July and August. Safety in thick weather lies in the constant use of the lead and keeping a bright lookout, as the dead reckoning is frequently in error to a considerable extent. The most serious difficulty is the faulty work of the compass, especially off Digges Island, at the western end of the straits, where the magnetic pole is approached and the dip of the needle is 86°. This means great vertical force, with the horizontal force approaching the vanishing point. "The latter may be considered," says Lieut. Gordon, "as that portion of the earth's magnetic force which determines the direction of the needle, when counterpoised to hang horizontally; the vertical force is that by which induction in the iron of the ship to a great extent affects the deviation or ship's errors." In making a voyage from Great Britain to Hudson Bay the dip changes from 67° to nearly 87°. The practical meaning of this is that, supposing a residual error of one degree left uncorrected on one of the cardinal points when adjusting before sailing, this would—since the deviation changes with the tangent of the dip—have become an error of 6° when the ship had gone to a place where the dip was 87°.

As the mouth of the Churchill River, emptying into the bay at an angle in the coast lying between Cape Churchill and Seal River, offers the finest harbor in these waters, the following description from official sources may prove valuable: At its mouth the river flows nearly north, the estuary is narrow, being only some 600 yards wide. Here the tide runs with considerable velocity, estimated at half tide to run six knots. The basin for anchorage, with a depth at low water of over four fathoms, is about 1,500 yards north and south by about 1,000 yards east and west. The holding ground is good, the bottom being mud, and though the tide runs rapidly, the harbor is pronounced an eminently safe one. The approaches are well marked, and in clear weather the land stands out bold and high, being easily identified at a distance of ten or twelve miles. In thick weather the rule for making the harbor is to steer W. by S., keeping in 20 fathoms of water. If shoaler water is met with, haul up to the north at once till the water deepens again. The harbor is well adapted for a railway terminus, as the necessary docks could be easily and cheaply built and the deep water basin enlarged at small cost. Stone lies at the water's edge ready to be laid into docks or piers, and nature seems to have left little to be done to make this a capacious port, capable of doing business on a large scale.

Port Nelson, where is situated York Factory, the great *entrepot* in years gone by of the Hudson Bay Company, was selected, not because of any harbor facilities, but because the Hayes River, which enters the bay on one side of the tongue of land on which York Factory lies, was the best boat and canoe route to and from the interior of the country, a route which was the only means of communication with the early settlers of Red River and Selkirk settlements. The company's ships on arrival could not come up to the fort, owing to shoals, but discharged their freight into schooners in the outer roads, ten miles from the nearest land, which lies so low as to be out of sight from a ship's deck, the only distinguishable object being the Point Marsh Beacon, which towers up 80 feet above high water, and without which it would be impossible to make the anchorage even in clear weather. This condition of affairs practically precludes Port Nelson from ever being used as a commercial harbor.

Apart from the question of the navigability of Hudson Bay as a practicable route for the transport of grain and produce, its resources are great and capable of far more extension than they have yet received. In fact, a few New England whalers and the Hudson Bay Company have had everything in their own hands. Whale and porpoise fishing, walrus hunting, salmon and trout fisheries, and rich mineral resources, offer advantages in a comparatively new field. Water fowl abound, of which ducks of all kinds, geese, the trumpeter swan, which breeds on the islands off the east coast, loons, curlew and plover are the most common. The coast and islands of the bay are the main breeding ground of these birds, where they have been undisturbed for centuries and unapproached by man. On the land, as far as the limits of trees and brushwood extend, grouse and ptarmigan are in abundance. Large game is well distributed, and of bears, in addition to the polar, another species frequents the "barren grounds" south of the straits, the skin of which so closely resembles that of a grizzly as to pass for a variety of the latter in the trade. Dr. Bell, the geologist, accompanying the Canadian expedition in 1884, mentions a very curious fact. His party killed on Digges Island, on September 16, a she polar bear and two cubs, the stomachs of which were found to contain nothing but partially masticated grass. About four quarts of this were present in the stomach of the old bear, and two and a half and one and a half quarts respectively in the stomachs of the cubs. The Eskimo and Hudson Bay Company's servants informed the party that these bears are in the habit of occasionally using grass for food. Whether this is from preference or from the want of small game is doubtful, but in the case here recorded it could hardly have been from the latter at that period of the year. The musk ox is found only on the northwestern shores of the Bay, principally round Chesterfield Inlet. Before the Eskimo obtained firearms from the Hudson Bay posts in trade, they used in the chase the bow and lance, the former made of two or three sections of musk ox horn, tipped with the shorter horn of the reindeer, and lashed with its sinews. The barren ground cariboo is the commonest of the large game found on both sides of the bay. Its migration is notable, for spending the winter along the border of the low forests southward, it travels north on the approach of spring. Its quite gray color so closely assimilates to the "barrens" that it is no easy matter to sight it at once, and the sportsman should approach down-wind. The cariboo is to the Eskimo what the reindeer is to the Laplanders; but the numbers annually killed for the sake of their tongues, which are shipped to the London market, is materially thinning their ranks, and they may eventually share the fate of the bison.

Whaling in Hudson Bay has, according to Lieut,

Gordon's reports, for many years been carried on by United States vessels, chiefly from the ports of New Bedford and New London. This voyage is made in comparatively small vessels, and occupies about eighteen months. Leaving their New England port in June, they make their way to Marble Island on the northwest of the bay, arriving there some time in September, and going into winter quarters. As many as four whalers at one time have wintered there, and on Deadman's Island, appropriately named, a long row of graves bears testimony to the trials and hardships these men undergo in pursuit of their calling. After wintering the vessels are cut out early in June, cruise about the bay till August, and leave for home in September. A table was published in 1887 by Lieut. Gordon, showing that, in the twenty-five years preceding, 113 United States vessels, engaged in whale fishery, had visited Hudson Bay, the total catch of which was 1,620 barrels of sperm, 56,019 barrels of whale oil, and 900,083 pounds of whalebone, while during that period 16 vessels engaged in the trade were lost.

Comparing the above catch, and that the average size of the vessels is only 240 tons, the margin for profit is considerable. Vessels such as these, however, are only a risk, and must class as fishing boats, being in no way adapted for any other purpose than what they are engaged in. But the vessels recommended as practicable for the purpose of commerce must be, not the cheaply built freight steamer, but vessels of about 2,000 tons gross, fortified for meeting ice, and of such construction as to enable them to be fair freight carriers. They must be well strengthened forward, should have wooden sheathing, and be very full under the counter. The propeller should be of small diameter, and well down in the water. A limit of 2,000 tons is stated, as a larger ship would be unwieldy, could not make such good way through loose ice, and, being unable to turn sharply, would get many a heavy blow that the smaller ship would escape.

Already several railways are projected from different points in the Northwest to Hudson Bay, notably one from Winnipeg, and another from the Calgary and Peace River districts, over which much of the grain and a large portion of both American and Canadian cattle from the western ranches would be carried, and European goods for those districts would furnish return freight. The recent completion and opening of the Edmonton and Calgary Railway is rapidly filling up a very important agricultural country, and the near proximity the Hudson Bay route would afford to European markets will extend its benefits to the south of the boundary line. A railway running southwest from a port on the bay will materially alter existing conditions, and its extension, as proposed, into the United States or to connect on the western frontier with the American railway system of the Western States, will be productive of a large traffic both ways. Cold storage accommodation already exists at Calgary in connection with the shipment of frozen meat in refrigerator cars to the Pacific coast, a trade which has far exceeded the expectation of its promoters. With the shipbuilder and capitalist rests the solution of the problem of this new line for commerce to take, and if such parties will construct and equip vessels suitable for the route, not on the lines of the ordinary ocean freight steamer, but specially adapted for ice and northern waters, there is every reason to believe that such an enterprise would prove remunerative and successful.

That this great lone sea will become to North America what the Baltic is to Europe, is only a question of the near future.—*Nautical Magazine.*

## HARDY CRINUMS.

THERE are half a dozen kinds of crinum in cultivation which may be classed among hardy plants in the warmer parts of England. They are, of course, happiest when planted in a sheltered border, preferably against a south wall, at any rate in the neighborhood of London. I suppose the hardiest of the six is C. capense, now called C. longifolium, with its two varieties album and Farinianum. These three are represented by large clumps in the borders at Kew, where they have been in flower for the past two months. The flowers of the type are rose colored, with a band of dull crimson down the middle of each segment; those of the variety album are white, with a faint streak of rose on each segment.

Farinianum was introduced from the Kalihara desert by Mr. Farini, of Westminster Aquarium fame, and presented to Kew, where it flowered in 1887. It is remarkable for its narrow, long-necked bulb, very long tapering leaves, and dark, rosy flowers. Mr. Farini found the plant in thousands in a stream mixed with rushes, the whole of the bulb and neck being buried. The species is very common in South Africa, whence it appears to have been introduced into England before Miller's time. Herbert had a large bed of it out of doors at Spofforth over sixty years ago, and his observations upon it are worth quoting here. He says: "It is a very hardy species, endures the winter, and flowers in profuse succession during five or six months in a bed covered with leaves in winter, and ripens seeds by the bushel. It delights in wet and will flower in a pond. . . . It might be advantageously planted by the edge of any ornamental piece of water, and would form a beautiful clothing for a small island, where it would afford thick covert for water fowl. Nursery gardeners might easily rear it from seed to sell by the hundred."

The following species had been successfully hybridized with C. capense in Herbert's time: C. zeylanicum, C. pedunculatum, C. exaltatum, C. scabrum, C. latifolium, C. Careyanum, C. revolutum, C. defixum, C. asiaticum, C. erubescens, C. cruentum. The offspring of these combinations were all in cultivation in Herbert's time, and some of them he describes as being very beautiful and quite hardy. So far as I can learn, none of them are in existence now, but the parents are, and what Herbert and his contemporaries accomplished could be easily repeated.

The only hybrid crinum in cultivation now is C. Powelli, raised by Mr. Powell, of Southborough, Tunbridge Wells, from C. capense and C. Moorei. Mr. Powell communicated the following note respecting the origin of his beautiful hybrid to *The Garden* in 1886:

"This hybrid crinum was raised from seed in Suffolk ten years ago, and having within the past two or three years become widely distributed in many districts both in England and Ireland, its complete hardiness may be said to have been thoroughly tested, and those who have grown it find it to increase in vigor and size yearly. All it wants is to be planted in a suitable spot, and if not meddled with, it will then take care of itself. It seems to grow twice as fast as C. Mooreanum in Kent, though Mooreanum, as seen out of doors at Glasnevin, is most satisfactory, both as regards foliage and bloom.

"I have tried Powelli in a pot, but could not get it to thrive, though in the same house Mooreanum succeeded well. The leaves of Powelli have great substance, and taper to a point; whereas those of Mooreanum are uniform in width and soft, and out of doors easily broken. They are not rigid and erect, like those of Powelli, which they somewhat resemble in color, being quite distinct from the glaucous green and prostrate leaves of C. capense. The flowers of Powelli vary in color from pure white to deep rose, but bulbs of the white kind are very scarce as yet, and it does not develop many offsets. Strange to say, the white-flowered plants were obtained from C. capense roseum; while those from C. c. album (which was also used as a seed parent) had the deepest shades of rosy pink. The flower stems of Powelli reach fully five feet in height when the bulbs are well established; the latter must be planted deep, with plenty of manure beneath them, but not in contact with the bulbs. This variety has never shown any signs of producing seed, but it has not been fertilized with any pollen except its own."

In the garden of Sir Trevor Lawrence at Burford Lodge there is a grand bed of C. Powelli; Mr. Gumbleton also grows it well at Cork, and it thrives in the open border at Kew. Planted with the base of the bulb a foot below the surface in an open well-drained border of loam it is quite happy and as regular in its copious production of large handsome flowers as either of its parents. It may be propagated from offsets, which it produces rather freely, as do also both C. capense and C. Moorei.

I suppose C. Moorei is the best of all the cool-house or hardy crinums. It is a superb plant for the conservatory, as may be seen from the grand specimens of it now in full bloom in the greenhouse (No. 4) at Kew. It is deciduous, requires to be kept dry in winter and liberally treated in regard to soil and water in summer. It is not quite as hardy as C. capense, scarcely thriving out of doors in gardens near London, severe winters, such as our last, being too much for it. But in the extreme southern counties, such as Devon, Dorset, etc., in South Wales and in Ireland no doubt it would be quite as hardy as C. capense is here. It has been a feature in the open border at Glasnevin for years. It is a native of Natal and Kaffraria, whence it must have been introduced into England at least twenty years ago. According to Mr. Baker, it was first made known to botanists by a sketch sent to Kew by Bishop Colenso in 1838. It has been called C. Colensoi, C. Makoyanum, C. Mackenii, and C. natalense. Its present name was given by Sir Joseph Hooker in compliment to Dr. Moore, of Glasnevin, who grew it successfully and supplied the specimen drawn for the *Botanical Magazine* (t. 6,113).

The variety album, of which a figure is given in the supplement of the current issue, prepared from a plant flowered at Kew last year and in bloom there again now, is similar to the type in all characters except the color of the flowers, which in the ordinary C. Moorei are pink, but in album are pure dazzling snow white. The Kew bulb of the latter was obtained from Mr. E. H. Woodall, of Scarborough, who obtained it from Madeira under the name of C. giganteum, and who states that he saw it there in a garden represented by a grand clump with thirty spikes of its snow white blossoms on long stalks above the bright green foliage. He asked for a bulb, never dreaming it would be possible for such a magnificent crinum to be hardy, or nearly so, in England. There is a figure of it in Regel's

CRINUM MOOREI ALBUM.

"Gartenflora" (t. 1,072), where it is called C. Schmidtii.

Other kinds of crinum are being tried outside at Kew, among them being the beautiful white-flowered C. brachynema, which Mr. Smith, of the gardens at Mentmore, has in abundance, and has shown in flower several times at the drill hall. It is a native of the Bombay Presidency, and has been introduced several times, but hitherto has not become an established garden plant, notwithstanding the size and beauty of its fragrant, pure white flowers. In an unheated frame at Kew it produced a flower spike last summer, and it is in healthy growth now. Mr. Smith gives it warm-house treatment. C. latifolium, of which I lately received a flower spike from the outdoor garden of Lord Ilchester, at Abbotsbury, near Dorset, is also likely to prove hardy in sheltered situations. C. Americanum, from the Southern United States, ought also to do in a greenhouse if it is not quite hardy. C. variabile, from the Cape, is another which ought to be as hardy as C. capense, or, if Herbert is correct, even hardier, for he states that out of doors it preserves its leaves in winter longer than C. capense, and it grows earlier in spring.

There is an exceptionally rich and varied collection of material available for the hybridizer in the eighty or so species of crinum known. Many of the species have large flowers produced in many-flowered umbels, and there is plenty of variety in form and color. The stature and habit of the species also vary from the huge, broad-leaved C. asiaticum, six feet high and eight feet wide, to the low-growing C. podophyllum and C. purpurescens, both tropical African species, which were in bloom in one of the stoves at Kew a few days ago. Some of the species flower freely and continuously, and others flower at intervals several times during the year. It is evident that they intercross freely, and they readily ripen seeds. There is much useful information upon the subject of breeding and cultivating crinums in Dean Herbert's classical notes on "Hybrids and Crosses," which form a supplement to that mine of botanical and horticultural bulb lore, Herbert's "Amaryllidaceæ."—*W. Watson, in The Gardeners' Magazine.*

## THE CONDOR, THE PENGUIN, THE SLOTH.

IN the Museum of Natural Sciences, in Madrid, are three specimens of animals that belong exclusively to the fauna of America. The accompanying cuts, for which we are indebted to *La Ilustracion Española y Americana*, are reproductions of drawings made from nature by Mr. Felix Badillo.

*The Condor.*—Over the high peaks of the Andes soars the condor (*Vultur griphus*, L.), the enormus vulture of which so many fables are told. Its color is blackish, and at the base of the neck it has a collar of white feathers; the head is bare, or has only light downy feathers at intervals, having on the upper part fleshy caruncles. It is the largest bird of prey, and the largest of the birds that really fly. It prefers, like the vultures of Europe, flesh that has begun to decompose, although, sure of its strength, when pressed by hunger, it attacks living animals.

In the description that, according to Lopez de Gomara, the Mexicans gave of the bird painted on the standards of Montezuma, we can recognize this colossal vulture.

*The Penguin.*—Another name for this bird is *Aptenodytes patagonica*. It is a palmiped which is unable to fly on account of the construction of its wings, and, on account of its compressed and badly formed tarsi, it is scarcely able to walk. When on land it assumes an upright attitude and moves in an unstable manner. Although this bird cannot fly, and can scarcely walk, it is a marvelous swimmer, all its organization being so arranged as to fit it for swimming. Its feathers are very short and flat, like the scales of a reptile, and therefore the study of these birds is of great importance for evolutionists.

THE SLOTH (*Bradypus bidactylus*, L.)

*The Sloth.*—The Spaniards, who first saw this creature in America, called it "the lazy fellow," and also, by way of antiphrasis, "Perico ligero" (quick Perico). Naturalists classed it with the monkeys, but it undoubtedly belongs to the order of edentates. It lives on large trees, moving slowly, because of the formation of the brachial artery, at its origin, into a very complicated plexus that renders the circulation in the extremities difficult. Generally it remains suspended and immovable, hanging from a high branch. It is well fitted for this position by the arrangement of the ligaments which pass from one phalange to the other. The subject of our engraving is the *Bradypus bidactylus*, L.

## THE SECRET OF THE HEAVENS.

By J. ELLARD GORE, F.R.A.S.

MANY are the books bearing such titles as "The Wonders of the Heavens," "The Marvels of the Heavens," "Mysteries of Time and Space," "The Story of the Heavens," etc. But few works on astronomy—at least, popular works—make any reference to what may justly be considered as the secret of the heavens. My readers may wonder what is this great mystery which I term the "secret of the heavens." Do not the heavens contain many mysteries? They certainly do. Mystery is attached to many, indeed, we may say, to most, of the heavenly bodies. Even within the bounds of our solar system we have several mysteries. For instance, the constitution of the sun, the real construction of Saturn's rings, the condition of Jupiter's surface, and of the surface of Saturn also; the so-called "canals" of Mars, the origin of the numerous craters which cover the surface of the moon, the constitution of comets, and other problems, all of which astronomers would like to see solved satisfactorily. When we extend our study to the stars, the mysteries further increase, and the enigmas seem more difficult of solution. We find, for instance, those mysterious objects, the variable stars. I refer especially to those of long period, and some of short period, in which the light is constantly varying. Then we have the "great nebulæ" in Orion, Andromeda, and Argo, the pale blue objects known as planetary nebulæ, and those still more wonderful systems known as spinal nebulæ. Respecting the real nature of these mysterious bodies even the spectroscope does not give us much information. It is true that it shows some of these objects to be masses of glowing gas, but it seems as yet impossible to identify some of the bright lines of these gaseous nebulæ with any known terrestrial substances. It has been established with certainty that hydrogen gas forms one of their constituents, but with reference to the other elements they contain we seem to be still in the dark. But even if we knew their true chemical composition, it would still remain a mystery how they are maintained in a state of glowing incandescence. These and similar mysteries confront us at every step we take, or try to take, in the way of research.

I do not, however, allude at present to any of these mysteries or enigmas. The "secret" I refer to is what I consider to be *the* great mystery of astronomy. It is this: What is the construction of the starry heavens? What is the relation of the nebulous-looking zone called the Milky Way to the system of brighter stars which stud our midnight sky, and the position of both in space with reference to our sun and solar system? Considering space as infinite—as we seem bound to do—is our visible universe limited, or boundless in extent? These are questions which have hitherto been only partially answered, and they constitute a mystery which may well be termed the "secret of the heavens."

Let us first consider the relation of the Milky Way to our sun and solar system. Accurate observations have shown that the Galactic zone forms very nearly a great circle of the celestial sphere. Most of my readers will know that a "great circle" of a sphere means a circle round a sphere the plane of which passes through the center of the sphere, and divides it into hemispheres. Now what does this fact regarding the Milky Way denote? It implies clearly that the earth, and, therefore, the solar system, lies in, or nearly in, the general plane of the Milky Way. This seems to suggest that the sun is closely connected with the Galactic system. The appearance presented by the Milky Way led Sir Wil-

THE CONDOR (*Vultur griphus*, L.)

THE PENGUIN (*Aptenodytes patagonica*, GM.)

liam Herschel to propose the theory that the vast cluster forming the stellar heavens is shaped like a "disk," or block wheel, the diameter of the "disk" lying in the direction of the Milky Way, and its thickness in the direction of the poles of that zone. This "disk theory," although it was certainly abandoned by its illustrious author in his later writings (as was clearly shown by Struve in 1847 and by Proctor in recent years), has for some reason persistently held its ground in astronomical text books. It is now, however, considered to be utterly untenable by nearly every astronomer who has studied the subject. An examination of Dr. Boeddicker's beautiful drawing of the northern portion of the Milky Way, recently published, will I think be sufficient to convince any reasoning mind that the Galactic zone is *not* shaped like a disk, and that any little evidence which ever existed in favor of such an hypothesis has now been finally refuted. Possibly the Milky Way may be simply what it seems to be, namely, a vast ring of small stars partially broken up. Its exact construction has, however, yet to be determined. Certain portions of this wonderful zone may perhaps be much nearer to the earth than others; but as we are still ignorant of the distance of any part of it, it is impossible to determine whether its component stars are of average stellar size, reduced to faintness by immensity of distance, or whether they are really small, and comparatively near us. The late Mr. Proctor favored the latter view, and I am disposed to agree with his opinion. It is worth noting that the two nearest stars in the heavens—as far as we know at present—Alpha Centauri and 61 Cygni, lie in the Milky Way, and we have really no reason to assume that these stars are very much nearer to the earth than many of the faint stars with which they are apparently associated. The fact that in some binary stars the primary is physically connected with a companion five magnitudes (and even more) fainter than itself should teach us caution in concluding that a bright star is necessarily nearer to the earth than fainter stars situated in the same region of the sky. Brightness is certainly no test of distance, for we know that 61 Cygni, a star of only the fifth magnitude, is actually a little nearer to us than Sirius, the brightest star in the heavens.

But even if we knew the exact constitution of the Milky Way, this knowledge would not enable us to satisfactorily answer the question, Is our visible universe finite or boundless in extent? For even if we knew the exact distance of the Galactic zone, there might still be numerous stars beyond that zone belonging to our sidereal system. We have, therefore, to examine the question from another point of view. There seems to be little doubt that the number of the *visible* stars is really limited. Most astronomers now admit that the total number of stars visible in our largest telescopes cannot much exceed one hundred millions. This is, of course, a large number, but compared with an *infinite* number it is really very small. It may be proved mathematically—and the demonstration is a very simple one—that were the number of stars really infinite, and equally distributed through infinite space, the whole heavens would shine with the brightness of the sun. Far from this being the case, the amount of light afforded by the stars, even on the finest nights, is very small, and the comparative blackness of the background on which they are scattered is sufficiently obvious. The number visible to the naked eye, even with very good eyesight, is not only comparatively but *absolutely* small. Some unreasoning people think that the number visible in this way is almost "countless," but an attempt to count those *distinctly* visible in any portion of the sky—for instance, in the "square of Pegasus"—will, I think, convince any intelligent person that the idea is merely an optical illusion, and a popular fallacy which has no foundation in fact. The number visible to average eyesight on an ordinary night does not much exceed 4,000 for both hemispheres. For exceptionally keen eyesight, and a very clear sky, we may perhaps allow a total of 10,000 for the whole star sphere, or 5,000 visible from any one place at one time. But surely this is a very small number, scattered over the whole expanse of the heavens. Five thousand men could easily be placed on a small field without touching. Allowing a space of four feet square, or sixteen square feet, for each man—a liberal allowance—I find that over 5,000 men could be placed without touching each other on a field of two acres (a field about a hundred yards square). Now, if we were to rise in a balloon over this two acre field, we should see a large number of heads, but there would be a lot of ground visible between the heads, and if we rose to a height of say two miles, the field would dwindle to a mere speck on the earth's surface.

To show what a limited number even one hundred millions is, I may mention that, from a rough calculation, I find that in a ten acre field of ripe oats the number of grains of corn probably exceeds the number of the visible stars; and we should have to multiply the number of the stellar hosts by at least ten to obtain the number of human beings now living on our comparatively tiny world!

To account for the limited number of the visible stars, some astronomers have suggested that the light of the stars suffers absorption in the ether of space, and that at a certain distance the stellar light must be wholly cut off, so that the most powerful telescope which can ever be constructed by man would fail to pierce through the "cosmical veil" which shrouds the more distant stars from our view. There are, however, several objections to this hypothesis. I will mention one or two. M. Celoria, using a small telescope of power barely sufficient to show stars to the eleventh magnitude, found that he could see almost exactly the same number of stars near the northern pole of the Milky Way as were visible in Sir W. Herschel's large telescope, showing that here, at least, no increase of optical power will materially increase the number of stars visible in that direction, and that probably very faint stars do not exist in this region of space. Sir John Herschel, speaking of his observations at the Cape of Good Hope, says, "We are not at liberty to argue that at one point of its circumference our view is limited by this sort of cosmical veil which extinguishes the smaller magnitudes, cuts off the nebulous light of distant masses, and closes our view in impenetrable darkness, while at another we are compelled by the clearest evidence telescopes can afford to believe that star-strewn vistas lie open, exhausting their power and stretching out beyond their utmost reach, as is proved by that very phenomenon which the existence of such a veil would render impossible, viz., infinite increase of numbers and diminution of magnitude, terminating in complete, irresolvable nebulosity;" and Prof. Grant says, in his "History of Physical Astronomy," "If such a hypothesis were true, we might reasonably presume that, in consequence of the light being everywhere extinguished at the same distance, the Milky Way would present a uniform aspect throughout its course. As, however, observations of the actual aspect of the Milky Way do not accord with this conclusion, the hypothesis from which it is deduced is manifestly inadmissible."

In a memoir recently published by Professor Schiaparelli, the famous Italian astronomer, on the distribution of the stars visible to the naked eye, he discusses the question of the supposed extinction of stellar light. Finding that the hypothetical extinction would reduce the light of very distant stars to an enormous degree, he rejects the hypothesis as improbable. Admitting, however, a very small and slow absorption—for instance, one eight-hundredth of the light at the distance of stars of the first magnitude, as supposed by Olbers—he suggests that possibly this small absorption may be due to very finely comminuted matter scattered through interstellar space. Assuming the most probable distance for stars of the first magnitude, he computes the quantity of matter which would be necessary to produce the assumed absorption, and finds that the quantity would be so small that, if all the particles scattered through a space equal in volume to that of the terrestrial globe were collected together, they would form a small opaque ball a little less than one inch in diameter! If we consider the tenuity of a comet's tail, we can well admit the existence in space of matter in such a finely divided state.

But even if we do not admit any extinction of light within the limits of the sidereal system, we may, I think, explain the limited number of the visible stars in the following way. Suppose each star to be attended by a family of planets—as many of them probably are—forming a solar system similar to our own, as in the hypothesis proposed by Lambert in the eighteenth century. Call each of these systems a system of the first order. Then suppose all the visible stars, clusters, and nebulæ—the Milky Way included—to form a system of a higher order. Call this a system of the second order. We may then imagine an immense number of these systems of the second order to exist in infinite space, which, all combined, would form a system of the third order; and so on to higher orders still. But for our present purpose we need not go beyond systems of the second order.

Assuming now the distance of the nearest fixed star—or the distance between two solar systems, or systems of the first order—to be 4,500 times the diameter of our solar system (which is about correct for Alpha Centauri), or the diameter of Neptune's orbit, and the distance of the faintest stars visible in our largest telescopes at 2,300 times the distance of the nearest fixed star (corresponding to the distance of stars of about the seventeenth magnitude). If we further assume that the distance between the systems of the second order bears the same ratio to the diameter of our sidereal system that the distance between two stars of that system bears to the diameter of the solar system, I find that the distance of the nearest external system from the earth would be expressed in miles by the number 520 followed by eighteen ciphers, a distance which light, with its immense velocity of 186,000 miles per second, would take nearly ninety millions of years to traverse!

This hypothesis affords an obvious explanation of the fact that the visible stars and nebulæ are limited in number. They all form part and parcel of one great sidereal cluster—our visible universe—which is separated from all external galaxies by a vast starless void, in the same way that the solar system is separated by empty space from the surrounding star-sphere.

The invisibility of the external galaxies may be explained, either by supposing a "thinning out" of the ether beyond the limits of our sidereal system or by supposing a small extinction of light to take place in objects placed at immense distances. The light of even the nearest external universe, enfeebled by a distance of twenty million times that of Alpha Centauri, might well be extinguished altogether by a very small absorption of light in such a vast thickness of a fluid medium perhaps not absolutely perfect. I find that Alpha Centauri placed at such a distance would, even if there were no absorption, be reduced to a star of the thirty-sixth magnitude, which would theoretically require a telescope of over 24,000 feet in diameter even to glimpse!

We are, however, not precluded by this hypothesis from supposing that numerous similar systems may exist in external space, and although we must consider the number of the *visible* stars as strictly limited, the number of suns and systems really existing, but invisible to us, may still be practically infinite.—*Gentleman's Magazine.*

## THE VALUE OF MAIZE AS HUMAN FOOD.

By CHARLES J. MURPHY.

THERE is no question more important or more pressing for a nation than that of the cheapness and extent of its bread supply. Yet it is a strange fact that England has availed herself but little of a grain that Americans have always found to be wholesome, cheap and nutritious. Maize, the most prolific cereal of the new world and the only food of the sturdy pioneers that founded cities and established governments, has, despite its proved qualities as a human food during centuries, yet to win its way in England and other countries of Europe! Traveled Englishmen who have been in the States have been struck by the various uses to which Indian corn or maize is put, and how important a part it plays in American domestic economy, as it furnishes more variety of food than wheat, and has the additional advantage of being more digestible, besides costing less than half as much as the better known grain. Maize is about the only great product of America that is not appreciated in Europe. Our wheat, cotton, fruits and meats are now well known in the world's markets, but save for distilling and cattle-feeding purposes, maize is still shunned for use in the human dietary by the people of the British Isles and the greater part of the Continent except in some districts of Italy and other places in Southern Europe. Mention should be made that a product of maize known here as corn flour has a considerable sale abroad, but that is only a starch which is made from maize, and though wholesome enough, it is not specially nutritious, as the muscle-forming and bone-forming elements are not found in the starch. The starch fattens only, it serves very well as desserts and puddings, but much more advantage can be derived from the whole grain itself in the form of mush or porridge, breads, cakes etc., as is done in the United States, corn starch being regarded as only one of the many foods obtainable from maize.

This wonderful product maize, which has conferred such substantial benefits on the world, strange to say, is of unknown origin. A learned author, after much thought and investigation, concluded with the expression: "Like that of wheat and barley, its origin is lost in the twilight of antiquity."

It was first cultivated in the United States by the colonists on the James River, Virginia, in 1608, the seed of which was obtained from the Indians, who claimed to be the originators or first discoverers of the plant, receiving it direct from the hands of the Creator. Schoolcraft gives their mythological history of it: "A young man went out in the woods to fast at a period of life when youth is exchanged for manhood. He built a lodge of boughs in a secluded place, and painted his face a somber hue. By day he amused himself in walking about, looking at the various shrubs and wild plants, and at night lay down in his bower, through which, being open, he could look up into the sky. He sought a gift from the Master of Life, and he hoped it would be something to benefit his race. On the third day he became too weak to leave the lodge, and as he lay gazing upward he saw a spirit come down in the shape of a beautiful young man, dressed in green, and having green plumes on his head, who told him to arise and wrestle with him, as this was the only way in which he could obtain his wishes. He did so and found his strength renewed by the effort.

"The visit and the trial of wrestling were repeated for four days, the youth feeling at each trial that, although his bodily strength declined, a moral and supernatural energy was imparted, which promised him the final victory. On the third day his celestial visitor spoke to him. 'To-morrow,' said he, 'will be the seventh day of your fast, and the last time I shall wrestle with you. You will triumph over me, and gain your wishes. As soon as you have thrown me down, strip off my clothes, and bury me on the spot in soft fresh earth. When you have done this, leave me, but come occasionally to visit the place, to keep the weeds from growing. Once or twice cover me with fresh earth.' He then departed, but returned the next day, and, as he predicted, was thrown down. The young man punctually obeyed his instructions in every particular, and soon had the pleasure of seeing the green plumes of his sky visitor shooting up through the ground. He carefully weeded the earth, and kept it fresh and soft, and in due time was gratified by beholding the matured plant, bending with its golden fruit, and gracefully waving its green leaves and yellow tassels in the wind. He then invited his parents to the spot to behold the new plant. 'It is Mondamin,' replied his father; 'it is the Spirit's grain.' They immediately prepared a feast, and invited their friends to partake of it, and thus originated Indian corn."

Longfellow, in his beautiful poem, "Hiawatha," refers to this legend:

> "All around the happy village,
> Stood the maize fields green and shining,
> Waved the green plumes of Mondamin;
> Waved his soft and sunny tresses,
> Filling all the land with plenty.
>
> "Before the summer ended
> Stood the maize in all its beauty,
> With its shining robes about it;
> With its long, soft, yellow tresses;
> And in rapture Hiawatha
> Cried aloud, 'It is Mondamin!'
> Yes, the friend of man, Mondamin."

In extent and variety of its forms and uses, few plants will bear comparison with maize. The plant itself is the most beautiful of all the cereals, and a field of it in full growth is at once lovely and impressive. The long, gracefully tapering dark green leaves are surmounted by bright, straw-colored blossoms, and as they wave and rustle in the breeze, the sight is charming to the eye. From the stalk grow the ears, which nestle among the leaves, being further protected by a sheathing of many folds, from which depend silken tassels called "corn silk."

Our annual surplus of corn or maize is enormous, and it is a very pertinent and a very important question to find a market for the largest part of the surplus. We manage, indeed, to get rid of it annually in various ways, in feeding cattle and hogs, as a part of the food of our people, the making of glucose, which manufacture is of late years assuming enormous proportions; we also use immense quantities in the manufacture of beer, starch, and whisky, and in preparations sold as table delicacies. The latest discovery has been the production of oil from the germs, and two manufactories are now turning out considerable quantities, which meet with a ready sale.

The canning of sweet green corn is also increasing enormously. Of considerable importance is the use of corn fodder for domestic animals, for besides the extensive use of grain there is the utilization of the juicy stalks and leaves, and now that ensilage is coming into favor, the consumption of cow corn has become very large. Perhaps the most singular use to which corn has been put is that of fuel, as has sometimes happened in the treeless regions of the West. It has been burned and found a thoroughly good substitute for wood or coal.

Every part is utilized, even to the husks, which are used by paper makers as a material for pulp; by upholsterers as filling for mattresses and the like; by orange growers of Southern Europe for packing fruits; by the South Americans as cigarette wrappers, and is much used for a kind of coarse door mat. But enough has been said to make it plain that corn must rank among the most useful plants known to man.

But it is more to the purpose to speak in these pages

of its availability for England and other European countries as human food.

Chemical analysis demonstrates that while the water contained in maize is slightly less in proportion and the ash slightly less and the crude carbohydrates but slightly more in proportion, the proportion of oil or fat 5·2 per cent. against 2·16 per cent. in wheat, the proportion of albuminoids is 10·46 per cent. in maize against 11·95 per cent. in wheat, and the proportion of digestible carbohydrates 70·69 against 71·98 per cent. in wheat. That is, roughly speaking, maize contains more than five-sixths as much of the albuminoids, not 2 per cent. less of the digestible carbohydrates, and twice as large a proportion of the fats. In nutritive value then it cannot be reckoned with any scientific reason that maize is worth five-sixths less than that of wheat. Maize, therefore, brings a price at present far below its real value, and this is solely because its nutritive properties are not sufficiently known.

The monotonous sameness of the diet in the households of the poorer classes of England has been often commented upon, tea and bread being taken in many cases where maize could replace the same as a more varied and cheaper food. There is no sturdier race than the American husbandman, who feels no disdain for a diet of mush and milk, and the British workman is well aware that the toilers of America are not weaklings in muscle or brawn. In 1828 it moved William Cobbett to indignation to see how much was wasted by the poor of this country in rejecting a food which is a staple dish in every American family, yet since his day there has been but little progress in its introduction among his countrymen. For hygienic reasons alone it would be well to add to the diet of this country a grain which has proved so acceptable to the people of the new world, both North and South America.

One of the greatest problems confronting the statesmen of Europe to-day is the question of maintaining the present enormous military establishment, imposed upon each country by existing conditions, at the highest point of possible efficiency with the lowest charge upon the tax-burdened citizen. The ration to be issued is a serious question; the necessity from a hygienic point of view of supplying a diet concentrated, highly nutritious, and at the same time varied enough to meet the requirements of modern dietary demands, is apparent. Maize makes a concentrated food stuff palatable and nourishing when properly prepared, and is especially valuable for use where muscle and hard labor are required.

Its value during our civil war received the most crucial test which could possibly be applied, and the wonderful strength and endurance shown by combatants on both sides is sufficient evidence of its value. It is apparent that its adoption as part of the army ration in European countries would be highly desirable, looking at the question from all points of view. The advantage to the governments would be in the fact that it would give as a part of the ration a grain cheaper than any other in first money cost, and a supply certain and abundant, not subject to such fluctuations in production as wheat or rye, being better adapted than most other crops to withstand our climate disabilities, drought especially. Its use would mean increased military efficiency for the whole body, as well as increased comfort for the individuals making up the service.

There can be no more effective recommendation for a new food than on the score of its healthfulness, and this can well be claimed for maize, both from its inherent qualities and its history as a food. For constipation it is a preventive and a cure, and it is stated on good authority that the use of maize is a potent remedy for dyspepsia. This seems reasonable enough when it is remembered that dyspepsia was scarcely known in America fifty years ago, when maize was the principal food. This special healthfulness is not due probably to any peculiar element which it contains, but most likely to its mechanical properties, by which it stimulates the action of the alimentary canal. It contains less gluten than rye or wheat and of a kind not separable by water. It does not therefore require much leaven of any sort to lighten it; no matter how heavy apparently or how close its particles may be, they are not agglutinated and are easily separated in the process of mastication and digestion.

During the last few years many improvements have been made in manufacturing maize for table use. Hominy, for instance, which required about two hours to prepare in the old style, has now been superseded by a specially manufactured hominy which has been steamed in the process of manufacture and necessitates only a few minutes' cooking before being ready for serving.

The knowledge of the various delicacies and inexpensive dishes that can be made from maize will come as a revelation even to the American housewife. There are upward of one hundred and thirty recipes for boiling, baking and cooking the great American staple, and they have all been tested and approved by the American cuisine, so she need have no fear of venturing on untrodden ground.

Corn starch, hominy, pop and sweet corn, mahogany colored loaves of Boston bread, Indian pones, golden Johnny cakes, corn mush, Indian pudding, corn dodgers, green corn pudding, corn griddle cakes, corn meal, crumpets, corn waffles and gophers, croquettes and corn fritters, canned corn and succotash, pinole, samp, corn grits, cerealine flakes, and numerous other corn preparations are produced which are as pleasing to the eye as they are grateful to the palate.

The investigation of the subject of maize as human food will amply repay the effort expended, whether by economist, statesman, philanthropist or housewife, and it is with absolute confidence that I believe the people of Great Britain and of the Continent, when they are aware of the merits of this food, as proved by the experience of a large portion of mankind for centuries, will properly appreciate this beneficent gift of the Creator and will thus add one more of America's products to its rightful place in her national dietary.—*Milling.*

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A FRENCH scientist, Victor Mennier, has calculated that American dentists insert about $450,000 worth of gold annually into the teeth of their customers. Making allowances for the increase of population, in less than a hundred years American cemeteries will contain a larger amount of gold than now exists in France.

## THE CULTIVATION OF COFFEE IN JAMAICA.*

By C. G. LLOYD.

THE island of Jamaica exports each year between eight and nine hundred thousand pounds of coffee, valued last year at a million three hundred and sixty thousand dollars, and the product was last year 15·7 per cent. of the total exports from the island. In former years the great bulk of this coffee went to England; thus only ten years ago, England got 73 per cent., while the United States only received 13 per cent.; but beginning with 1884 the States have taken a large proportion of the product, and last year received 45 per cent., the year before 57 per cent. I am very sorry to have to report, however, that the United States only gets the poorer grades, the English paying a better price for the choice grades. The best coffee of the island is raised on the Blue Mountains, in the parishes of St. Andrew and St. Thomas, the eastern end of the island, which coffee almost entirely goes to England. I am informed by the planters of Manchester parish, who sort their coffee, that their best grades, also, go to England.

Jamaica (and also Hayti) coffee is of an average good quality, a little stronger than Java or Mocha, but not so strong and rank as the Rio. A large New York importer of West Indies products told me that a certain coffee firm, whose name is a synonym for wealth, had made a fortune in the last half dozen years, selling roasted Jamaica and Hayti coffee as "choice Java." I presume those knowing nothing of the subject have an idea how coffee grows, even if it is erroneous. We naturally imagine that it grows on trees like cherries, and I had expected to see a coffee plantation look like a cherry orchard. When I left Kingston by rail for the interior of the island, a couple of weeks before Christmas, having been told that the coffee berries were then ripe, I kept a sharp outlook for the coffee trees, but saw nothing that I could take for them. On arriving at the station, I walked along the single road or street of the little village of negro huts, and chancing to stop by the side of a copse of tangled bushes which I took for a wild growth, I noticed a few coffee berries on the ground under the bushes, and on investigating found that these bushes were coffee shrubs. I tried to think of what they reminded me at home, and nothing conveys to my mind a closer comparison than a tangled undergrowth of wahoo shrubs.

The bulk of the coffee of Jamaica is raised by small growers, negroes, who own from a half to five acres of ground, and who plant the shrub around the place without any order or system whatever, and apparently give the shrub no attention, excepting to break off occasionally the tops when they get too high or to cut off a few dead branches. In the statistics of the island, where the estates are specified which raise fifty acres or more of coffee, only thirty estates are named, comprising about 3,000 acres, while the acreage of small holders, less than fifty acres, is nearly 18,000. These small growers, of course, for the most part have no machinery for preparing or sorting the coffee. Almost every negro hut in the coffee districts has in the yard what they call a "barbicue." It is a flat drying surface, built where the sun will strike it, and reminds one of a square tray on a large scale, built of brick with raised edges and cemented smooth. The usual size is from twelve to twenty feet square. The negroes gather the coffee berries when they get ripe, a few each week, somewhat like we would pick gooseberries, one at a time. They put the berries into a wooden mortar and beat them, which separates the outer skins, which are washed away in buckets of water. The seeds are then put on the "barbicue" to dry. Without a close examination at this stage the product resembles large grains of coffee mixed with the imperfectly separated outer skins, but on closer observation we notice that each grain of coffee is inclosed in a thick, tough, cartilaginous skin. When the coffee has been dried on the "barbicue" this skin becomes brittle, and the negroes again beat it in the mortar to hull it out of this skin. Then the seeds are picked over by hand, the better part of them being sold to the little stores throughout the country, which we notice with the sign out, "Licensed to deal in agricultural products," and which pay Her Majesty's government two pounds each per year for the privilege. These small storekeepers send it to Kingston, from whence it is shipped abroad. Coffee merchants in Kingston, and some of the merchants in the smaller towns, sort the coffee into grades according to size and weight of the berry. Most of the sorting is done by hand, though some have sizing machines, as described further on.

On coffee plantations the same process is gone through, but on a larger scale, more systematic, and with the aid of machinery. The coffee shrub thrives best on new land; hence the portion of the plantation devoted to coffee growth is virgin soil cleared of its forest for this purpose.

Around Mandeville, in Manchester parish, the land is now almost all pasturage, and I am told that the whole of it was originally cleared off for the growth of coffee many years ago in slave times, and having raised its crops of coffee and exhausted the ground for this purpose, it was sown in Guinea grass and used for grazing. To establish a coffee plantation the land is cleared of its trees, burnt over, and cleaned up. Then it is laid out by pegs into squares of six feet, and young coffee sprouts about a foot high are planted near each peg. These sprouts are generally obtained from beneath old shrubs, and are adventitious growths from seed dropped from the shrub, though sometimes nurseries are established for raising the young sprouts from planted seed. In these tropical regions, weeds and vines and wild growths of all kinds spring up very quickly, and with these the planter is constantly at war. Four times a year, at least, the fields should be gone over with a hoe and the weeds cut down. In three or four years the young coffee plants begin to bear, and the shrubs continue giving crops for about thirty years. The shrub, if left to grow, would reach a height of twelve to fifteen feet, but on a plantation they are topped when about four feet high, and kept to about this height by breaking off the tops and such suckers as appear. The branches are slender, and when the shrubs are not crowded, spread nearly horizontal. The leaves are evergreen (as indeed are most of the shrubs and trees in the tropics), of a firm texture, smooth and shiny above. They are opposite, oval, entire, and borne on short petioles about one-half an inch long. They are three to five inches long, two to three inches wide, and are terminated by acuminate points.

The flowers are white, borne in clusters of three to six in the axils of the leaves, and are exceedingly fragrant. The petals are five, slender, spreading. The shrubs begin to blossom in February and continue in flower up to May; the fullest bloom is in March and April. Coffee does not blossom as our fruit trees, all at once, and go out of bloom in a week or two, but continues to bloom for about four months, and the crop in consequence ripens through the same length of time, and the planters are thus enabled to gather and care for it to better advantage than if it all ripened at once. The coffee season lasts from September to December, September and October being the principal months. The coffee berries are borne on short stalks in clusters of three to six in the axils of the leaves. When ripe they are about the size of cherries, but are oval (not globular), and slightly compressed on the side. Each berry consists of two seeds (familiar to us as the green coffee of commerce), each seed inclosed in a thick, tough white skin called the parchment skin, placed in the berry with the flat surfaces together, and surrounded with a small quantity of sweetened pulp, the whole inclosed in a thick skin like a Malaga grape. The color of the skin when ripe is red, not a bright red like a cherry, but a pale, dull red.

The berries are picked by negro and coolie women, who go over the coffee shrubs, picking the ripe berries into baskets, and are paid by measure. The price varies according to abundance of the berries, but is regulated so that a woman makes about ninepence (18 cents) a day. Rats are very fond of the sweetish pulp that surrounds the coffee grains, and they climb the shrubs and gnaw off a great many berries. Birds are also said to pick them, and lizards—which are very numerous in Jamaica—are charged also with despoiling the fruit. This "rat" coffee is picked from the ground by the women, and comprises about one-fourth of the crop. It furnishes a larger proportion of heavy grains than the berries gathered from the shrubs, as the rats are credited with selecting the largest and best berries, and it is kept separate in all the subsequent operations. As the bulk of this coffee is supposed to be gnawed off by the rats, all coffee picked up from the ground is called "rat coffee." It costs about double to gather it as when picked from the shrubs.

The women bring the berries to the works, where they are measured and paid for by the "busher," as the overseer of a coffee plantation is called. To prepare the coffee for market the berries are first run through a machine, called the "pulper," which tears off the outer skins and pulp. A "pulper" is simply a large cylindrical wheel about three feet in diameter and two feet long, covered with corrugated iron, like a nutmeg grater, and arranged so that it revolves so close to another corrugated iron surface that the berries cannot go through entire, but are caught by the rough surfaces and torn to pieces, the skins and pulp being carried through, the seed dropping beneath into a tank of water. The water serves to wash the grains, and also to separate the light from the heavy coffee; the former floating, are skimmed off; the latter sinking, are taken from the tank after the water is drawn away. Heavy coffee is much the better grade, and it is kept separate from the light in all subsequent operations. At this stage the coffee seeds are still in the "parchment skins," which are tough and cannot be separated from the seeds when green; hence the next process is to thoroughly dry the seed in order to make the "parchment skins" brittle so they can be hulled off. For this purpose the seeds are spread on "barbicues" similar to those previously described, only, of course, on a larger scale. The "barbicues" of an ordinary sized plantation cover about an acre of ground, and are usually built on sloping ground and terraced. When it threatens a shower, and every evening to protect it from the rain and dews (which are heavy in the tropics), the coffee is raked into a pile in the center of each "barbicue" and covered with a wooden cover-shaped hopper. From ten days to two weeks' exposure to the sun on the "barbicue" will dry the seeds so that they can be hulled. The "huller" is a large wooden wheel, arranged to revolve like the wheel we see in brickyards, but running in a circular narrow trough. The coffee is placed in this trough, and the wheel constantly running over it breaks off the brittle "parchment skins," being heavy enough for this purpose, but not so heavy as to crush the seeds. The coffee seeds are separated from the broken "parchment skins," called trash at this stage, by being run through a "fanner," similar to the fans of our thrashing machines, which blows off the trash. There still remain closely adhering to many grains of coffee thin light gray skins, called "silver skins," which would hardly be noticed by the ordinary observer. To remove these skins and brighten the grains of coffee it is further dried in the warehouse for two or three weeks, and again put through the "huller" and "fanner." The next step is to separate the "pea berry coffee." A small percentage of the coffee berries, instead of containing the normal two seeds, have by abortion only a single seed. The grains of these single-seeded berries, instead of having a flat face, are rounded, and are called "pea berries." These "pea berries" are heavy and of the best quality, and bring a better price than the best grade of flat-faced grains. To separate them the coffee is run into a cloth belt slowly revolving at a slightly inclined plane, the flat-faced grains being carried over the top, the rounded "pea berries" rolling off the bottom.

The coffee is next graded according to the size of the grains by being run through a "sizer." This is a cylindrical screen, consisting of four sections of different sized meshes, the smallest holes near the top. The screen revolves at an incline, and the different sized grains drop through the various sections, according to size, into bins beneath, the largest grained and best grade being carried through the cylinder.

Finally, the coffee is given to women, who spread it on a table and pick out all the deformed or broken grains, which are called the "tringe." The best grades

* Read before the American Pharmaceutical Association at the Profile House, N. H., July 16.—*Amer. Jour. of Pharm.*

of coffee are put in tierces holding about 800 pounds, and mostly shipped to England—the poorer grades and "tringe" into barrels or bags for this country.

I have given a description of the machinery which I saw in operation on the plantations. There are improved machines, I am told, but they are said to furnish no better results than the old ones.

In concluding this article, I wish to acknowledge my indebtedness for information and other courtesies to John H. Nosworty, the "busher" of Somerset plantation.

## RECENT ARCHÆOLOGICAL DISCOVERIES IN OHIO.*

FOR many years there has been considerable speculation in scientific circles concerning the movements of aboriginal man in the Ohio Valley. In fact, little was known about the real primitive man, but much knowledge was assumed regarding a mythical people called the "Mound Builders." From meager investigations of the few interested in archæology it was supposed that the mound builders erected stone walls, possessed a knowledge of geometry, knew the value of metals, employed a written language, and, in short, were sufficiently advanced in arts and trades to be considered civilized. Recent explorations by various institutions and individuals have corrected these prevailing erroneous impressions.

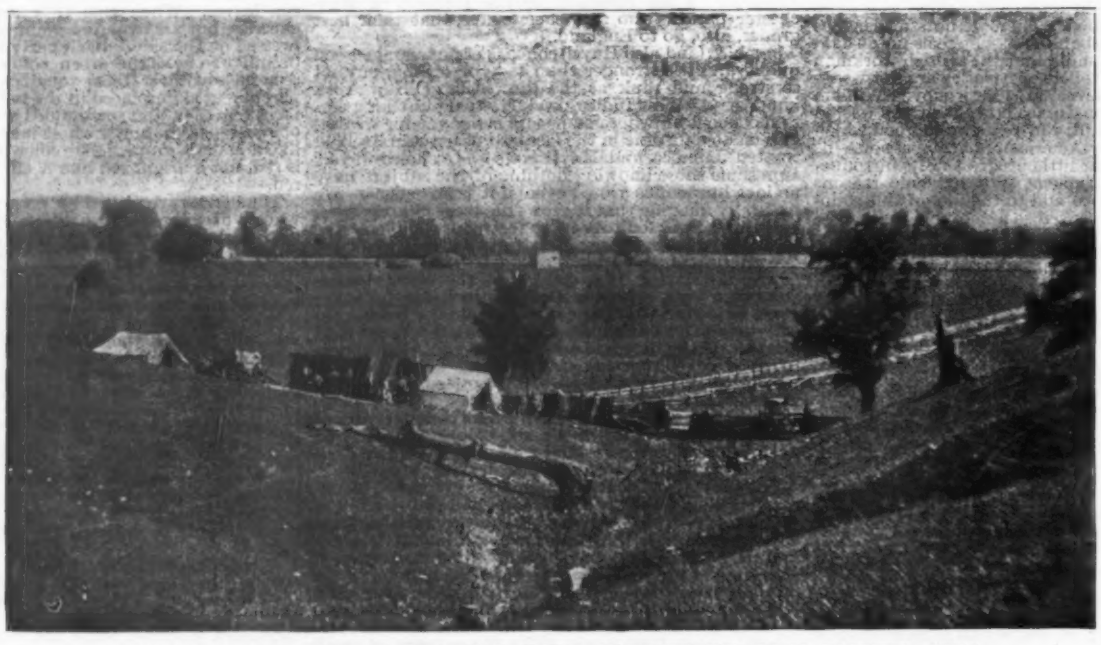
With all the interest manifested in American archæology, no thorough work was projected in the field until ten years ago. Then the Peabody Museum, the Bureau of Ethnology of Washington, and several citizens of Ohio awakened to the importance of the subject and began an extensive examination of ruins and camp sites according to the methods observed by English and French archæologists. A great deal of literature previously published upon the subject had attracted widespread attention, but was valueless because the authors were inexperienced in field work. They based conclusions upon surface indications and did not thoroughly excavate in the mounds, graves, or village sites of the people whom they attempted to describe.

Good work has been done by Messrs. Squier and Davis in 1844–46, by Professor Putnam, Dr. Metz and the Madisonville Historical Society in the Miami Valley, by Messrs. Fowke and Reynolds under the direction of the Bureau of Ethnology in the Scioto and Muskingum Valleys, by Prof. G. F. Wright in the glacial drift, and by Professor Putnam in various parts of the State in the interest of the World's Columbian Exposition. From an inspection of the collections and reports of the institutions named it will be seen that a great deal of work has been projected in certain counties. But with all the labors of the individuals named, some of the largest and most important village sites and cemeteries remain unexplored.

In 1887 three of us made up our minds to devote several seasons to archæological work. Accordingly we took the field in the spring of 1888 and continued, with but few interruptions, until the first of April, 1891, when we ceased exploring at our own expense and entered the service of the World's Columbian Exposition. During this period of three years we had employed from five to fifteen men, projected work in eight counties, examined upward of two hundred fortifications, mounds, and village sites at a total expense of about $12,000. The collections which were made comprise some twenty-one thousand objects, and were loaned the Smithsonian Institution, where they are now on exhibition.

In July, 1889, we located at Fort Ancient, in Warren County, O. Excavations were carried on until the close of October of the same year. In April, 1891, when in the service of World's Fair, we returned to the fort and investigated upon a larger scale than in previous years. The fort itself has been frequently described and the readers of the SCIENTIFIC AMERICAN are doubtless familiar with its characteristics; but the village sites and graves found near the structure are of unusual character, and hence it might be well to add a few words concerning them.

There are three large village sites in and about the fortification. The most important one occupies the low bottom land bordering upon the Little Miami River. The second is upon the high hills to the east (three hundred feet above the river) and is surrounded by the walls of the southern portion of Fort Ancient. The third lies upon the plateau a half mile north of the structure. In the two former sites are numerous graves in small groups of from six to twenty. We herewith present an illustration of the graves as they appear in groups, and two of the skeletons when the grave has been opened. The ground above these graves contains fragments of refuse, such as pottery sherds, animal and fish bones, broken implements and ornaments, etc. In exploring, the location of graves is ascertained by thrusting a long sharp-pointed iron rod through the intervening three feet of loam. If a stone is struck the rod is shifted from one place to another until the position of the stone is known. In the village site bordering upon the river three groups were discovered about one hundred yards from each other. Seven graves constituted the group farthest up stream, fourteen were in the middle one, and seventeen lay in the southern cemetery. As will be seen by the illustrations, the graves are not parallel. Interments were doubtless made from time to time. None of the graves had a stone floor. From their appearance we would judge that the friends of the deceased excavated to the extent of seven by three feet, continuing the hole until a hard blue clay underlying the surface loam was reached. The body having been deposited, large limestone slabs were transported from adjacent creek beds and placed upon each side, at the head and at the feet. Earth thrown against the stones held them in position. The slabs were, of course, upon edge and had been selected as near as possible of a uniform size. Longer stones were rested from one side to the other across the grave to serve as a covering. We never found stones which had been dressed. The graves at the time of the interment were hollow, but because the stones did not fit closely, a great deal of earth in after years filtered in between the crevices. It is very rare indeed to find a grave which is still hol-



WORLD'S FAIR CAMP AT THE HOPEWELL EARTHWORK, ROSS COUNTY, OHIO.

* For most of the accompanying illustrations we are indebted to the *California Magazine*.

GRAVES AT FORT ANCIENT—SOUNDING FOR GRAVES WITH AN IRON ROD.

low; nearly all of them are at least partly, if not entirely, filled with earth.

In the tumuli, ornaments, ceremonials or implements usually accompany the skeleton. In the graves the burials are characterized by a lack of such objects. The only exception to this rule is in the case of children. A large percentage of the graves are small and contain the decayed remains of children varying from two to twelve years of age. In nearly all of their graves the love of the mother for the child was evinced in necklaces of beads, shell ornaments, pendants, and other simple toy-like objects.

In 1889 many interments were found in single graves in the same village site. Broad trenches were carried from the fence of the Little Miami Railroad to the bank of the river, a distance of two hundred yards. Our plan was to work ten men abreast, making each trench forty feet in width and three feet in depth. Six or seven trenches were run and some four months' time occupied in the work. Places exist in the field of one hundred to two hundred feet where there was no debris. So it was necessary to dig over the entire ground.

A great many spots were found fifteen or twenty feet in diameter upon which habitations had been erected. In such places ash pits were found and refuse heaps extending as far as six feet below the surface. The ashes having a remarkable preservative power contain perishable objects like fish scales and bones of the smallest birds and animals, pieces of cloth, buckskin, etc. When a death occurred in the family the remains were frequently interred in the ash pit. In ash pit burials no stone slabs surround the skeleton. We are unable to say whether the family lived in the lodge after the burial. Recently, when on an expedition in southern Utah, we learned that the Navajo Indians always bury their dead in the same lodge where the subject lived and leave the lodge standing, but the survivors move and erect a new home. Possibly the aborigines at Fort Ancient observed the same custom.

Near the mouth of Cæsar's Creek, seven miles up the river, we worked during the month of August, 1891, upon the farm of Mr. Hiram Taylor. Stone graves in groups exactly like those at Fort Ancient were discovered upon the high ground overlooking the valley. There was also a mound surrounded by a village site. The tumulus was but eight feet high and sixty feet in diameter, yet we found seventy-nine skeletons within it. Most of the burials were upon the original surface of the ground and many of the skeletons had various implements placed near the hands. In one instance a large flint dagger or sword fourteen inches in length

THE ALTAR FROM THE EFFIGY MOUND AT HOPEWELLS AND SOME OF ITS CONTENTS.

and sharpened at each end lay along the right femur of a very well preserved skeleton.

The Scioto Valley was by far more densely populated in pre-Columbian times than any other section of the State. Good springs were numerous, game was abundant, and the fertility of the soil was unexceled. In Ross, Pike, and Pickaway Counties primitive man found conditions most favorable for his existence, and he was not slow to avail himself of these natural resources. Along the main Scioto and in the valleys of the two Paint Creeks he erected large villages, fortifying his towns by earthern embankments—building his burial and ceremonial mounds within the inclosures. Wherever a large village existed it follows that numerous mounds were necessary. Wherever the population was considerable, the more skilled workmen in flint chipping, the sculptors of human and animal effigies, bird and fish likenesses, the carvers of shell and bone ornaments were attracted. At such centers their work would command more in exchange and they would be safer from the inroads of homeless, roving savages, such as lived in isolated portions of the State away from the larger streams.

It is perfectly natural that the archæologist should prefer to examine the large and extensive village sites and inclosures. In them he finds the implements and ceremonials representing the highest attainments of primitive man. In the small scattered mounds in the hilly sections of Ohio he finds hasty burials, crude and exceedingly primitive objects, diminutive skeletons, and the crania of a long-headed race (dolicocephalic).

With a view to exploring the ruins of the Scioto Valley, we spent the months of July and August, 1888, and March, April, May, and June, 1889, in Ross County. Upon the North Fork of Paint Creek in the edge of the village of Frankfort is a fortification of considera-

MAKING A SECTION THROUGH THE EMBANKMENT AT FORT ANCIENT.

ble extent. It occupies the same site of the famous Shawnee Indian town, Chillicothe. However, it is almost unnecessary to add that the Shawnees, who occupied the place in historic times, did not use the tumuli for burial places, and left their implements upon the surface and especially along a small creek a half a mile east of the mound.

Upon the farm of Mr. Tighlman Porter, whose dwelling is at the western side of the village, are five mounds. Three of them form a connected group a few yards south of the pike leading to Washington C. H. The two others are near together, about three hundred yards distant. Mr. Porter permitted us to open two of these.

The first mound opened was oval in outline, its dimensions being one hundred and ten by sixty feet, with an altitude of five feet. The bearing of the longer axis was north, thirty degrees east, and the greatest width was at a distance of forty-eight feet from the southern end. For distinction the point where these two diameters crossed will be called the center of the mound. The real center, of course, lay several feet further toward the north. Our work revealed a stone pavement about two feet in width near the base of the structure. It may be considered certain that when this pavement was laid the completed mound rose from its inner edge. This being the case, if all the earth washed from above and covering the pavement at the time of our exploration was restored to its original position over the upper surface, the height of the mound would not be increased more than four feet.

The following description of the mound, taken from "Primitive Man in Ohio," together with illustrations of the objects and ground plan, may prove of interest to the reader:

"Beginning at the south end of the mound, we extend a trench entirely through it, twenty-two feet wide at the margin. This was gradually extended until at the center it measured thirty-four feet—narrowing somewhat thence to the northern extremity. Thus we were at no time more than about seven feet from the circumference of the mound as it was built. As everything we found was within these limits, the results of the exploration would have been the same had every spadeful of earth been removed. To satisfy ourselves fully upon this point, we dug narrow trenches at several places toward the outer edge of the mound, always with the same result—finding only the stone pavement alluded to.

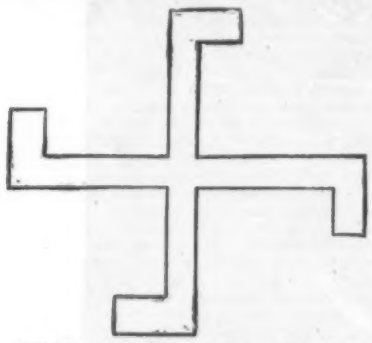
"There were two skeletons about three feet below the surface at the highest point of the mound; nothing

had been placed with them, and they were evidently intrusive burials.

"One foot below the surface, near the western side of the trench, about twenty-four feet from the margin at which we began, was the outer whorl of a sea shell. It measured six inches in width by ten and a half inches in length, and the whorl and edges had been cut down with great care, and had apparently been used as a vessel. It was filled with clean, fine sand, and lay with the opening downward.

"With these exceptions, there were no objects found anywhere above the base of the mound. Possibly the shell had been buried with a body whose last trace had disappeared by reason of its proximity to the surface. If this is the case, it may be reasonably looked upon as an intrusive burial, like the skeletons mentioned.

"The mound was distinctly stratified, although the



SWATISKA CROSS (Two-fifths size).
Original of sheet copper; Effigy Mound, Hopewells.

strata were not always regular, being thicker in some parts than in others. Beginning at the top, it was composed of:

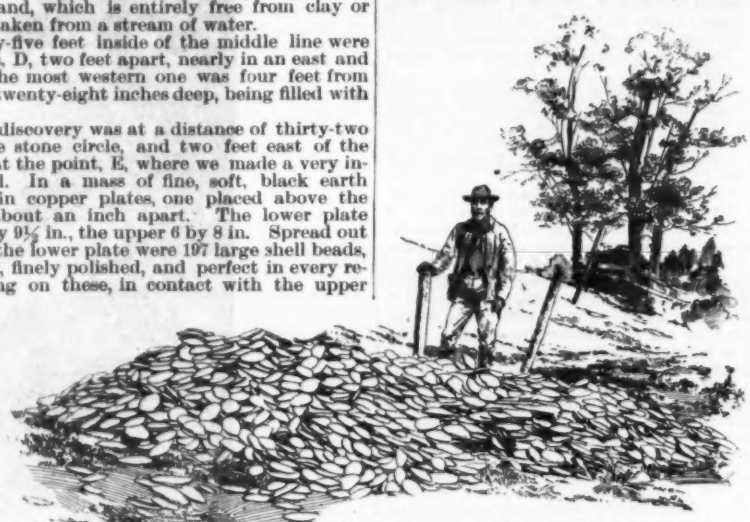
| | |
|---|---|
| Black soil | 1 ft. |
| Gravel | 1 " |
| Brown earth or loam | 3 in. |
| Yellow clayey loam | 3 " |
| Black soil | 6 " |
| Clean white sand | 8 " |
| Black soil containing pebbles | 3 to 4 " |
| Gravel mixed with clayey sand | 1 ft. |

"Immediately underneath the bottom layer, upon the original surface, we found the most remarkable deposits, both as to quantity and variety, that it had, dently taken place elsewhere. Alongside of these pieces of bone lay the outer whorl of a sea shell, C, measuring 7 by 12½ in. It was placed in a mass of very fine black earth, and, like the one near the top of the mound, was filled with sand.

"It may be a matter of some significance that all the shells of the kind that we refer to present this same peculiar feature. They are either wholly or partially filled with sand, which is entirely free from clay or gravel, as if taken from a stream of water.

"At twenty-five feet inside of the middle line were three pockets, D, two feet apart, nearly in an east and west line. The most western one was four feet from the line and twenty-eight inches deep, being filled with ashes.

"The next discovery was at a distance of thirty-two feet from the stone circle, and two feet east of the middle line, at the point, E, where we made a very interesting find. In a mass of fine, soft, black earth were two thin copper plates, one placed above the other, and about an inch apart. The lower plate measured 7 by 9½ in., the upper 6 by 8 in. Spread out evenly upon the lower plate were 197 large shell beads, neatly drilled, finely polished, and perfect in every respect. Resting on these, in contact with the upper



7,232 FLINT DISKS FROM A SINGLE MOUND AT HOPEWELLS.

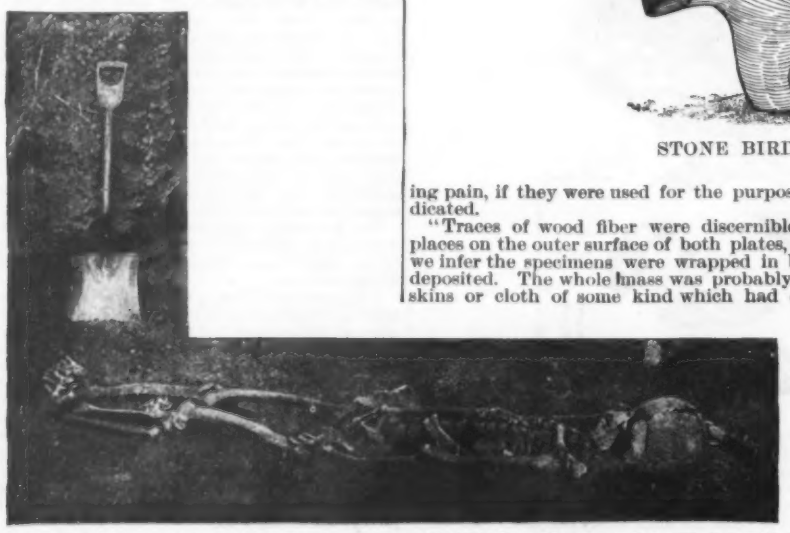
plate, were twenty-one of the copper spool-shaped objects, which Professor Putnam, curator of the Peabody Museum, is of the opinion were intended for ornaments to be worn in the lobe of the ear. They are made of two disks of copper, each having a double curvature, and joined by a hollow cylinder of the same material.

STONE BOWL (One-fifth size).

so far, been our fortune to unearth. We will describe these in the order in which we came upon them.

"To aid the reader in locating the various objects, we shall give their distance from the inner edge of the stone pavement, A, at the southern end, and east and west, as the case may be, of the longer axis, which may be called the middle line of the mound.

"At 14 ft. inside of and 4 ft. west of this line were some fragments of a cremated skeleton, B, small portions of the skull of which remained, showing very distinctly the marks of fire. The burning had evi-



SKELETON FROM MADISONVILLE CEMETERY. (Photograph by H. I. Smith.)

Around some of these cylinders were traces of leather, or a similar substance, which had been preserved by the copper, possibly a thong or a cord, by which they had been suspended, or something that had been used to prevent the rough edges of the copper from causing pain, if they were used for the purpose above indicated.

"Traces of wood fiber were discernible in several places on the outer surface of both plates, from which we infer the specimens were wrapped in bark before deposited. The whole mass was probably inclosed in skins or cloth of some kind which had entirely decayed, for the soft earth upon which they lay was certainly not natural soil.

"At the same distance from the margin as these plates were two skeletons, F F, one on either side of the middle line and about ten feet from it. Five feet farther on, lying six feet nearer together than the last, were two others, G G. All these had their heads to the southwest. The bones were so decayed that the various parts comprising the skeleton could not be taken out.

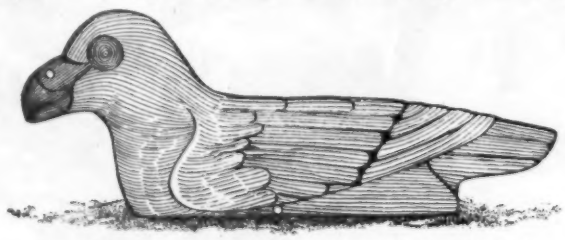
"At the center of the mound was a space two by four feet, H, where the earth had been burnt to a depth of three inches. On this was piled up at least six bushels of ashes in a dome-shaped mass. They were very fine, free from the slightest admixture of charcoal or other substance, and almost as white as snow. The fire from which they resulted, which had evidently been made of hickory wood, had been made elsewhere and the ashes carefully gathered and carried to the spot. No relic, fragment of bone, or any other object was found in or near the ashes or the burnt earth upon which they rested.

"Forty-five feet from the stone circle, and five east of the middle line, were two skeletons side by side, the heads pointing nearly east. Resting upon the skull of the first, I, was a copper plate, which had been beaten out so thin as to be almost destroyed by the damp

BEAVER, OR OTHER ANIMAL CARVING, EFFIGY MOUND, HOPEWELLS (One-third size).

ground in contact with it. Only small fragments of it could be secured. Immediately to the right of the other, J, was found a pocket, K, thirty inches deep, filled with ashes. A similar pocket, L, was found almost on the middle line, and about six feet west of it still another, M, which was covered by a layer of small stones, extending far beyond its edge on every side, to make a bed two feet across. Between the last two were traces of a skeleton, N, the head of which lay toward the north.

"The next skeleton, O, was fifty-eight feet from the stone circle, and five feet east of the middle line. Only one object had been buried with it. This was a very rare specimen, namely, an ornament made from the bone of a wild animal, and wrought in the form of some of the commoner forms of slate gorgets. It was well finished, with two perforations, and, although one end is broken off, so that the exact length cannot be determined, it probably measured about six inches when perfect.



STONE BIRD, EFFIGY, HOPEWELLS (Full size).

"At sixty-two feet in, and ten feet east of the middle line, we came upon another pocket, P. All of those previously discovered had been carefully examined and found to contain nothing but ashes. This one, however, was covered with a large sheet of mica, which gave promise of better results below. We were not disappointed in our expectations, for scattered through the ashes within the pit were nine hundred and ninety pearl beads. Most of them were very small, although a few of them were as large as buckshot. They were made from the common unio shells, so abundant in the streams of this region, and each one was neatly drilled.

"Just to the east of the pit were some small fragments of the cranium and other portions of a skeleton, Q.

"Two feet northwest of the pit was found a skull, which proved to belong to a well preserved skeleton, R, measuring over six feet in length, that lay extended with head to the south. On the forehead were five bear

tusks, each with several holes drilled partially through it. Probably all these perforations had formerly held smaller teeth, pearls, or some other objects which were supposed to enhance the beauty of the ornaments. One of them still holds the tooth of a ground hog neatly fitted into it.

"By the left side of the head lay four spool-shaped ornaments; at the top of the head were two flat beads, about three-fourths of an inch in diameter, made of mussel shell, each with two holes drilled in it. Near the right elbow was a copper plate, six by seven inches. The position of the skeleton, with the accompanying objects, is shown in the figure.

"At seventy feet in, and twelve feet west of the middle line, at a point marked S in the plan, we found one of the altars first described by Messrs. Squier & Davis, the first of the kind we had ever seen. A mass of clay had been worked or kneaded until of uniform consistency, and spread on the bottom in a layer about eight inches thick. It had been dressed off at the sides until

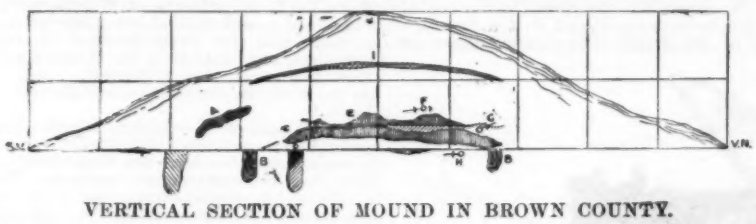
SKELETON FROM MIAMI VALLEY. (Photograph by H. I. Smith.)

the top was a rectangle twenty four by thirty inches, the corners being neatly rounded. A depression twelve by eighteen inches, with a depth of four inches, the corners rounded, like those of the outer perimeter, was then excavated, leaving a rim or border with a uniform width of six inches. After this the entire altar had been subjected to an intense heat, for we found it burned red and hard throughout, the basin being filled with ashes and small fragments of human bones almost destroyed by the heat. There were no means of ascertaining whether the altar had been burned before the cremation had taken place, or whether it had been allowed to dry in the air and hardened by the same fire that had consumed the body. We were very desirous of securing this altar, for no one had ever succeeded in removing one entire. The men dug carefully around it, leaving what we considered a safe margin of earth on every side, and then endeavored to lift it out. In spite of all our efforts it broke in two pieces, but each part was removed without further injury and placed in a large box. Unfortunately, we allowed it to dry out too rapidly, in consequence of which it cracked and scaled badly, and in a few days it was in fragments.

"Directly east of it, twenty-five feet distant, was a mass of burnt clay (T), irregular in outline, about four feet across and four inches in thickness. The surface was flat, and had no remains of any kind placed on it.

"Seventy-eight feet from the starting point and exactly on the middle line were two extended skeletons, laid near together, with feet to the north. Near the head of one (U) was a plate of copper six by seven inches and four spool shaped ornaments. The plate had fragments of thread adhering to both sides, as though it had been wrapped in cloth. Under the head of the other (V) were four more spool-shaped ornaments. Eleven wolf teeth were found among the cervical vertebræ. They were neatly drilled for suspension. Two perforated ornaments made from a mussel shell were also excavated. No doubt these had formed a necklace. Between the jaws were fifty pearl beads, which had evidently been placed inside of the mouth at the time of burial. The cranium was saved entire.

"The last thing in the mound was at a distance of eighty-two feet from our place of beginning. Here we came upon the edge of an ash bed (W), which measured seven by ten feet, and two feet in thickness, its long axis at right angles to that of the mound. Scattered about through the ashes with no regularity as to position, we found a number of flint flakes and twenty-six fine leaf-shaped implements, five plates of mica, cut out to perfect circles somewhat larger than a silver dollar; a celt of symmetrical form, highly polished, together with great quantities of calcined bones of various animals and birds. Nearly a half bushel of charred hickory nuts was also discovered and hundreds of fragments of pottery. The most interesting find was that of fourteen earthenware pots, each of a capacity of about two quarts. They had been placed in the ash bed, most of them with the mouth turned downward. Owing to the looseness of the ashes, we could easily uncover them sufficiently to determine their size and shape. It was impossible to get any of them out, as they were very soft and much broken, although all the pieces remained in their proper places—thus proving the vessels had been entire when deposited."



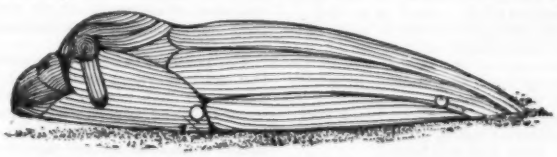

VERTICAL SECTION OF MOUND IN BROWN COUNTY.

A, earth, charcoal, and human bones mingled; B, "post holes," or excavations, below base of mound, which were filled with burnt rock; C, layer earth burnt red; D, black earth; E, altar containing skeleton; F, skeleton; G, a second skeleton; H, a third skeleton; I, layer of bark and charcoal.

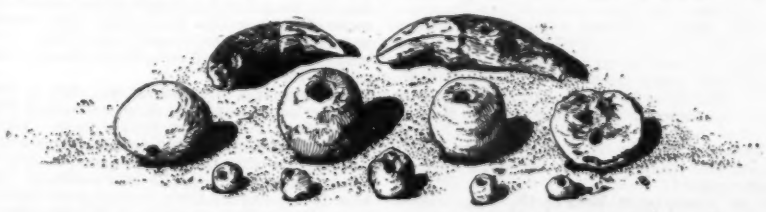
"It appears that this mound therefore contained many interesting features throughout almost its entire extent; while others much more imposing in appearance held nothing worth digging for."

In 1889 the second Porter mound was opened. It lies upon the southeast side of the pike and forms one of a group of three. Its height is nine feet and its diameter seventy-two. The character of the objects found and the burials much resemble those of the tumulus just described. However, more copper was found; one copper deposit in particular of several celts and spool-shaped ornaments occurring in a layer of gravel some distance above the base line. The crania were all of the brachycephalic type, as was noticed in the skulls of the other Porter mound. A large number of cremated skeletons occupied the northeastern portion of the mound. In some instances the bones were almost entirely consumed; others were burnt to the waist, with the upper part of the trunk and skull entire. Several were burned from the head downward to the hips, and nearly all of the cremated skeletons had more or less copper with them, which was greatly affected by the heat.

The most important skeleton taken from this mound is one which in our notes is known as G. It was well preserved and had been carefully extended upon a mass of soft black earth. At its feet was a copper plate seven by twelve inches, covered on both sides with the remains of cloth and wood. About the head and neck were six hundred and six beautiful pearl beads. Many of them were fully half an inch in diameter, all were drilled, and the greater part still retained their original luster. Among the vertebræ were eight perforated bear tusks, three spool-shaped ornaments. The teeth were discolored by the oxidized copper. Between the femurs lay twenty disk-shaped perforated beads, made from the mussel shell and well polished.



EFFIGY OF UNKNOWN BIRD, HOPEWELLS, ROSS COUNTY, OHIO (Full size).



BEADS AND TEETH FROM ALTAR, EFFIGY MOUND, HOPEWELLS.

The work at Chillicothe resulted in the finding of a great many interesting ornaments, implements, and ceremonials. In a large mound upon the farm of Mr. Janes, three miles southeast of Chillicothe, upon the banks of the Scioto, we found one skeleton which had evidently been interred a long time after the death of the individual. Indeed, the bones must have been transported a considerable distance, for not only are many of them absent, but those present are not in their proper order. The cervical lumbar vertebræ are missing, as are some bones of the hands and feet. The right radius is turned almost at a right angle to the ulna, and the right tibia lying across the left fibula, which is itself several inches out of its true position. The bones are unusually large and heavy. The breadth across the shoulders with the bones correctly placed was nineteen inches. The only relics found with it were forty shell beads near the right wrist.

At Oregonia, in the mound briefly mentioned in the commencement of this article (in which were seventy-nine skeletons), a great many partial interments were observed. Frequently the head and shoulders of the skeleton would be found lying doubled up, or possibly the long bones of the individual placed in a pile. A very interesting conclusion can be drawn from these facts. The Ohio savages were undoubtedly great warriors, and it is reasonable to suppose that tribes in pre-Columbian times held the dead in great reverence, as did the Shawnees, Delawares, Miamis, Mingoes, and such tribes as the French and English found in the Northwest Territory one hundred and fifty years ago. They warred with each other. The bodies of the slain on every battle field were doubtless horribly mutilated by the victors. The survivors of the defeated party would take with them to their village the bones of their fellow warriors. Hence our frequent finding of partial skeletons in the mounds.

In August, 1891, the survey took the field in the interest of the World's Columbian Exposition, locating at Anderson Station, Ross County, Ohio, upon the farm of Mr. Cloud Hopewell. The farm borders upon a beautiful stream, the North Fork of Paint Creek. There are some twenty-six mounds, nearly all of which are inclosed by an embankment. One hundred and eleven acres are within the fortification. The mounds vary from eighteen and twenty inches in height and thirty feet in diameter to one twenty-three feet in height, five hundred feet long, and two hundred and thirteen feet wide. The finds made in these mounds exceeded in importance in the vast number of singular implements and ornaments, in the multitude of burials, in the beauty and symmetry of the copper, obsidian, mica, stone and terra cotta designs and figures, any previous archæological discovery in the United States. From one of the mounds was taken seven thousand two hundred and thirty-two flint disks. The accompanying illustration gives an idea of the magnitude of the find. The largest mound, known as the Effigy, will doubtless become famous among archæologists on account of its peculiar contents. It would not be just to Prof. Putnam and the World's Fair directors to speak specifically of the work accomplished, as the investigations were carried on at the expense of the Fair; but a few general remarks will be permitted. The following account taken from an article by the writer in the April number of the *Californian Illustrated Magazine*, accompanied by illustrations kindly loaned by the editor of the above-named publication, may be of interest.*

"No single tumulus explored within the limits of the Mississippi Valley has yielded such a variety and wealth of archæological treasures as has the large structure near the center of the inclosure, which we designated the 'Effigy Mound.' It was called an effigy on account of its resemblance to the human trunk. Its greatest diameter is from the east toward the west. The eastern end is high and bold in outline, the western rather low. There are undulations on the top and projections on the northern side resembling shoulders. The builders had added to the mound at six or seven different periods, hence the irregularities in its outline and its consequent resemblance to the human trunk. The center of the mound is higher, and well indicates, by its gradual swelling, the chest. A little beyond the chest the mound is narrowed to a diameter of 160 feet, and this would indicate the waist. We speak of the mound externally, of course, when we say that it is a likeness of the human trunk. Internally, it gives no evidence of having been constructed in portrayal of the human body. Its likeness to that form is, therefore, purely accidental, and we have established the term more for the sake of convenience than to convey the idea of an intended effigy.

"A burial mound of such great dimensions as the Effigy could not be explored by a continuous trench or one large excavation. We had to divide the structure into seven sections, each sixty feet in width. These cuts were run north and south across the shortest diameter of the mound. Teams and scrapers were employed to expedite the investigation, and each section was dug out by scraping until a point four feet from the base line was reached. The base line is the original floor or bottom of the mound. The teams were then moved to another portion of the mound, and laborers with pick and shovel carefully examined the remaining four feet, beginning at the south end, on the base line, and working toward the north.

"In erecting the structure, primitive man had cleared the ground of underbrush and bushes, built a fire upon it and burned it hard, placed the bodies of his distinguished dead upon the level floor thus attained, and heaped the mass of earth above. So, by keeping along the hard burnt base line, excavating was rendered easy, and the positions of skeletons and objects located without difficulty.

"Section No. 1, or the first trench cut in the mound near the eastern end, contained nothing. Section No. 2 exposed several skeletons, accompanied by some interesting implements.

"Foremost among these was a large adult skeleton, five feet ten inches in length, whose head pointed toward the south. The men gave him the name of 'The

* The photographs from which these illustrations were made were taken by W. A. Richardson, Harland I. Smith, Clinton Cowen, and George Little.

King of the Mound Builders,' and although the name is more sensational than scientific, its implication may not be contrary to the truth. At his head were copper antlers, twenty-two by twenty-three inches. From the forehead and crown, and reaching to the base of the skull, was a heavy copper plate, bent and made to conform to his cranium. In his mouth were beautiful pearl beads, upon his chest and abdomen were copper plates, while his entire person glittered with mica, pearl beads, shell ornaments, and pendants. His faithful women had made for him a short skirt of rough cloth, similar to coffee sacking in texture, and where the copper had come in contact with it, it was very well preserved. Upon the ankles were strings of copper, spool-shaped objects and beads. Near his right shoulder was a large spear-head of agate. A pipe of fair workmanship rested near his jaws.

"Section No. 3 was by far the most important. In it were discovered three adult skeletons accompanied by many objects, a mass of singular designs in sheet copper, two skeletons covered by a layer of copper, a clay altar filled with ceremonial and ornamental objects, and many skeletons with and without objects. The burials in cut No. 3 were made promiscuously, that is, the skeletons were not placed at certain distances from the center of the mound or from the altar, nor was there any regularity observed in the placing of objects about the remains. Mounds are frequently described as containing skeletons placed in a square or circle, with the heads, in the case of a square, in each row pointed the same way. In all our mound exploration, we have never found all the skeletons pointed in the same direction. There seems to be no preference for any one cardinal point above the other.

"Particular attention is called to the evident lack of conformity in the burials in this mound. Because of the great richness of the structure, we would assign it a prominent place among the tumuli, the contents of which have given us substantial information concerning the origin of the Ohio primitive man. If there ever was any intention on the part of the mound-building clans to exhibit their knowledge of geometry or artistic arrangement of the burial places, we would have supposed that this knowledge would have been made manifest in this structure. But there is no evidence of an ability to make accurate measurements, nothing to indicate a uniform method in interring the dead. Even the most wonderful finds seemed to have been carelessly heaped together.

"Beginning at the south end and proceeding toward the north in cut No. 3, we found a deposit of copper very extensively with northern tribes, also that the natives of the Gulf States traded shells, mica, and fossil sharks' teeth for copper and fine flint implements. The effigies represent southern life, the obsidian Mexican, and the Busycon and Pyrula shells the North Carolina or Florida nations. Perhaps the Swatiska was known to the Aztecs. Several crosses have been sculptured upon the temples and tablets of Mexico and Central America. It is, therefore, quite reasonable to conclude that the more southern nations knew its use. The savage of the Ohio Valley did not, and therefore placed it with a mass of copper, most of which was designed for ornamental use only.

"The second deposit of copper lay 15 ft. north of the first and upon the base line of the mound. It covered two decayed skeletons. The objects were fairly well divided between copper plates and celts. The largest ax ever found in the United States, weighing thirty-eight pounds, twenty-two by five inches, lay near the western edge of the deposit. The other celts were smaller, some of them being but an inch in length, while the average weighed two pounds and were six by three inches.

"The copper plates were of nearly uniform size. The copper in them had originally been sheet, and was undoubtedly hammered thin in a cold state. They varied from a sixth to a quarter of an inch in thickness, were eight or ten inches in length, and six or seven inches wide. The corners were slightly rounded. Occasionally the plates were perforated for suspension.

"Beneath the copper lay two badly decayed skeletons. Copper usually preserves anything it comes in contact with. Yet, in spite of the great mass of metal above these skeletons, their bones were almost dissolved into dust. The remains were so far from the surface, atmospheric agencies could not affect them. With so much copper over them, all conditions were favorable for their preservation. We are, therefore, convinced of the great antiquity of the mound. Near the northern end of the cut lay an altar three by four feet in length, with several bushels of interesting objects and ornaments, all of which had been melted and run into one general mass. The copper was melted, the bone implements, the ornamental shell disks, and many of the effigies were cracked and calcined and very nearly destroyed by the intense heat. A conglomerate mass, in which are hundreds of ornaments of all conceivable materials, was taken from the center of the altar. It is two by three feet in extent.

"Nearly all the mounds in the Scioto Valley contain altars. Very few have been found in the tumuli of other sections of the State. The smaller altars contained nothing, the larger ones are usually filled with the possessions of the builders of the mound. Whether the offerings which they have deposited in the altar fire were in commemoration of the dead or in the observance of some ceremony, we are unable to say. The altar itself is invariably composed of clay and was moulded *in situ*. In the case of the larger altars, the rim about the cavity is eight or ten inches in width. The cavity is from four to six inches in depth, with sloping sides. It is usually burnt a bright brick red.

"Cuts Nos. 4 and 5 contained many skeletons. There was nothing remarkable with any of them.

"Cut No. 6 was almost as interesting as No. 3. There was a larger altar in this cut than in No. 3, and eight or ten times as many specimens in its cavity. Near the center of the cut were two skeletons, over whose heads stones had been neatly arched. The skulls were preserved, and we succeeded in removing them nearly entire, although the other bones of the body were badly decayed.

"Our conclusion is that the builders of the Effigy Mound were acquainted with the Mexican civilization and cotemporaneous with the mound-building period. There were hundreds of obsidian implements in the second altar, such as have been briefly mentioned above. Many of these were of the finest workmanship, varying in length from six to ten inches, and in width from three to five. Their edges were sharp and clearly defined. Barbs or shoulders for the attachment of shafts have been chipped with unfaltering precision. Some of the obsidian had been worked into long and delicate knives. Many of these were slightly curved like a sickle, while others were double-edged and dagger-like. Thirty or forty were secured entire, but the great majority had been cracked and broken by the heat of the fire, which, as in the case of the first altar, was built upon the deposit. How unfortunate that the builders resorted to this destroying element! How valuable to science would be these implements, effigies and ornaments, had they been deposited as were the two masses of copper!

"There were pipes, large bear teeth, copper spool-shaped objects, thousands of beads, little statuettes resembling human and animal figures, and many other things. One of the pipes represents a duck standing upon the back of a fish. The execution is admirable, all the parts of both being clearly defined. The hole for the stem runs through the mouth of the fish, and the bowl is in the back of the duck. A carving three inches in length and an inch in thickness represented a human face. The right side is badly damaged, the left side and the crown is entire. The nose is long and almost abnormally large. The cheek bones are not high and the chin is receding. Copper brooches and buttons covered with silver, bone beads, delicate bone needles, sandstone tablets, and thousands of flint flaked knives were taken from the deposit. All told, the finds from this altar alone filled fifteen large boxes. This will give an idea of the magnitude of the find. After the taking out of the second altar there were no more important discoveries. The six great deposits of this mound place it ahead of any similar structure in the world in archæological importance. Any one of four of the six deposits would have amply paid for the expense and time necessary for the exploration."

When the detailed report of the work done by Professor Putnam and his colleagues is published, the life of the prehistoric peoples in Ohio will be fully understood. The exhibit in Chicago in the professor's department will contain all the finds of the past year and a half. Archæologists can look forward with a great deal of pleasure to an inspection of the collections.

WARREN K. MOOREHEAD.

FLINT DAGGER, CELT OF COPPER, SHELL DIPPER, FROM HOPEWELLS (One-fifth size).

## DRINKING WATER A SOURCE OF MALARIA.

By RICHARD WAGGENER, M.D., Pensacola, Fla.

DR. CHAILLE, Professor of Hygiene, Medical Department, Tulane University, of Louisiana, stated in one of his lectures that although sanitarians generally admitted that malarial fever might be caused by drinking water contaminated with the poison, yet any evidence bearing on the subject ought to be published.

I have been struck so forcibly, time and again, during the past five years, with instances where the water supply was obviously the source of malaria, that I have concluded to write my thesis upon this subject. Not being on the ground, I will have to dispense with many valuable data and much information I could otherwise obtain, and will therefore confine myself to relating the three most important facts coming under my observation.

The writer has resided, during the past five years, on the Naval Reservation, near Pensacola, Fla., serving as Apothecary, U. S. N., at the Pensacola Naval Hospital, and assisting Surgeon John W. Ross, U. S. N., in a very large practice. The Naval and Army Reservations are situated on the north side of Pensacola Bay, about seven miles southwest of the city of Pensacola, and about one and a half miles from the Gulf. The Navy Yard, the villages of Warrington and Woolsey (combined population about 1,200), lying just without its walls, and the Naval Hospital, three-quarters of a mile west, are situated on the Naval Reservation, and Fort Barrancas, Army Barracks, etc., are situated on the Army Reservation, one mile west of the Navy Yard.

The villages of Warrington and Woolsey are at the present day extremely unhealthful places, being strongly malarious throughout the whole year, and especially so during the summer and autumn. This condition of affairs has existed during the whole period of my residence there, and certainly for some years previous, but the older inhabitants, many of whom have lived in the place since years before the war, all unite in declaring that previous to about the year 1872 the place was considered very healthful, that chills and fever were unknown, and that people from the interior would locate there for a time to recuperate from malarial troubles.

Having satisfied myself that the above was true, it was but natural for me to wonder why such a change had occurred in the healthfulness of the place, and to try to ascertain the cause. After carefully investigating the matter, I have concluded that the water supply of the villages in question is the source of the greater part of the malarial poison with which the inhabitants are afflicted, because the only change of a sanitary nature which has occurred to them since the time of their comparative healthfulness to the present day consists in their water supply, and in this they have made a very decided change, as I shall proceed briefly to relate.

The point of land upon which the villages of Warrington and Woolsey are situated is a low, sandy beach, about six feet above sea level, the soil consisting of a layer of sand, mixed with organic material, overlying a swampy and marly subsoil. Water is found in the driest season at an average depth of three and a half feet. Back of the villages there is a further rise of about forty feet, consisting of sand and clay. The villages are the offspring of the Navy Yard, upon the location of which potable water was sought and evidently found, consisting of two springs at the foot of the rise alluded to above, which boiled up out of the pure white sand, clear and cool even during the hottest part of the summer. The authorities in the yard, having at that time no reservoirs for collecting rain water, caused these two springs to be curbed in with brick for their own supply. These springs are still in existence, and are known as the "Commodore's Springs." This source supplied most of the drinking water to families residing in the villages, a small portion of them possessing cisterns, but preferring this water in summer on account of its coolness, until about the year 1872. About that time *driven wells* were introduced, and these being cheap, quickly put in operation and convenient, it was not long before almost every household had one or more of them in the back yard. The wells are driven, as a rule, only about twelve feet deep, some of them half that depth, and constitute the present water supply of the villages.

Another fact: In January, 1886, a marine guard, numbering about forty men, arrived at the Pensacola Navy Yard for duty at that station. These men came directly from the north, and were in fine physical condition. During their first year on the station they began to have attacks of remittent and intermittent fever; during their second year there was a much larger proportion of them on the sick list, and between July 1 and August 15 of their third year (1888) every man in the guard had an attack of either intermittent or remittent fever, twenty-five of the forty being in the hospital at one time. They were sent north to Norfolk, Va., on August 15, many of them, far from well, but their improvement was steady after leaving. On account of this circumstance, the department has not seen fit to send another marine guard to Pensacola. Surgeon John W. Ross, U. S. N., in his annual report to the Surgeon-General for the year 1888, says: "The

health of the marine guard grew worse almost steadily during their stay here (Pensacola), until in the early part of August, 1888, before the sickly season had reached its height, they broke down completely, and had to be carried away bag and baggage."

The marines during their stay at Pensacola, with the exception of a few months, occupied new cottage barracks built on the pavilion style, well ventilated, cool in the summer, and having their floors three and a half feet above the ground, open and well aired underneath.

The water supply of the Navy Yard consists in a brick cistern for each of the officer's quarters, and three large cisterns, with a combined capacity of 500,000 gallons, affording the general supply. The marines were supposed to get their drinking water from one of the large cisterns, the nearest of which is about 200 yards from the barracks, but unfortunately for them there was a driven well very near their barracks, from which, for obvious reasons, they derived the greater part of their drinking water.

On the other hand, the officers and their families residing in the yard used cistern water only, and they were entirely exempt from malarial diseases during the season of so much sickness among the marines, as they also had been before and have been since, sickness of any kind among them being little or none. At Fort Barrancas, only a mile from the Navy Yard, the enlisted men, more than double the number of the marine guard, used cistern water exclusively, and their health during the period of so much sickness among the marines was, as Post Surgeon M. C. Wyeth, U. S. A., at the time expressed it, "excellent."

The third fact is as follows: The present Naval Hospital buildings were constructed in 1875, on the foundations of the old hospital destroyed by fire during the civil war. The water supply consisted until the early spring, 1890, of two driven wells, eighteen feet deep. During the whole time this water was used the place was very unhealthful, the attendants having attacks of malarial fever every year, and patients admitted with other diseases would often develop malarial manifestations while at the hospital.

During my first year at the hospital I apparently escaped the poison, but during the two succeeding years, 1888 and 1889, I had several attacks of malarial fever, my wife suffered from it even more than I, and our little girl, during her first and second summers, had typical paroxysms of intermittent fever. In the spring of 1890 an old brick cistern, a relic of the old hospital, was repaired and put in use, since which time we have used cistern water only at the hospital for drinking purposes, and although two very sickly seasons have passed, there has not been the slightest evidence of malarial trouble of any kind in my family.

In conclusion, I will mention that the atmosphere of the locality of which I have written is probably, to a great extent, deprived of malarial poison by a strong south or southwest breeze, which prevails during the entire summer. Coming immediately from the Gulf, it is perfectly free from malaria when it arrives, but when it departs carries with it, no doubt, the morbific agent almost as fast as it springs from Mother Earth.—*New Orleans Med. and Sur. Jour.*

## THE DESCRIPTIVE ARTS AND THE EXACT SCIENCES.

THE artist copies, expresses or interprets nature, and he also does work of pure imagination. The poet may describe and the painter may represent beings that have never existed except in his imagination. Both may invent phenomena that science cannot explain. The reader or the spectator is apprised; he does not look for reality, but follows the artist in the development of his idea, puts his imagination in unison, and dwells for an instant in the domain of dreams. The mysterious adventures of a certain Hans Pfaal, of Poe, will lead no one into error, and although, from beginning to end, all the suppositions are but a tissue of absurdities, all is so well presented, all is so logically connected, that one is carried away with the imagination of the author, and might believe in the reality of the descriptions. No scientific man would think of criticising a work of this kind for its premises.

But entirely different are the demands that we may make of artists who have had the intention of representing a real object—a landscape as it exists. We must take the intention into account, and desire that the representation shall be exact, within the limits of the means that the artist has at his disposal. A painter rarely sees the subject of his picture as far as to its last details. Either for want of time to finish it *in situ*, or because he afterward decides to retouch it, in order to complete its harmony, he is often led to work a little from memory or sentiment. This is the case with the most conscientious artists, those who are the most faithful to nature, such as it is.

Let us go a step farther, and we shall meet with the category of painters (or literary men), who use scattered material, who make studies of a person in the studio, and studies of landscapes in the open air, and finally bring the whole together in one picture. Now it sometimes happens that, although each portion taken by itself is absolutely accurate, the *ensemble* is incompatible. The light is differently distributed, the relative dimensions do not accord well, the phenomena are impossible. Further along we shall give some examples of this. We shall recall, in the first place, a few literary errors.

A descriptive journalist, giving an account of the unfortunate burning of the Tuileries, took it into his head, in order to compete the picture, to bring the moon into the landscape. From Auteuil, where he was, he saw the alleged star rise behind the towers of Notre Dame. Now, on the day and at the hour that the fire occurred, the moon was in an entirely different part of the heavens. Let us distrust this planet; it plays many tricks with artists.

It is rare, it appears, to find scientific errors in the poets of antiquity. The prophets themselves have left us, in a language of imagery without doubt, and which needs to be interpreted, faithful descriptions of natural phenomena.

In a former article we have endeavored to show, from various astronomical works, how chronology can turn such observations to account.

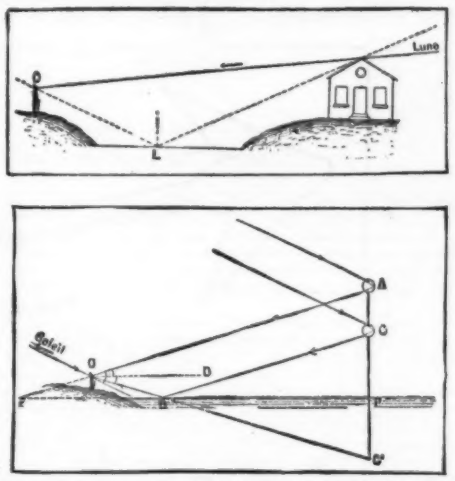
It is very fortunate that modern science is taught in works that have some chance of lasting at least as long as the works of poets. Were it otherwise, would not our descendants be led into error concerning our ac-

FIG. 1.—MOONLIGHT EFFECT FROM A PAINTING BY VAN DER NEER.

quirements by these verses of the great poet who has created so many admirable harmonies?

Le soir ramène le silence;
Assis sur ce rocher désert,
Je suis, dans le vague désert,
Le char de la Nuit qui s'avance.
Vénus se *lève* à l'horizon.

Let us return to painting. We got together the few observations that follow after reading a report of a very




FIGS. 2 AND 3.—EXPLANATORY DIAGRAMS.

interesting lecture by Mr. Norman Lockyer. The eminent astronomer, seeking in painting a few data that he was in need of, found, instead, a large number of errors, which he exposes. We borrow from him a few of these, which are typical.

We have said above that we may require of the artist a representation that is exact within the measure of his means. This restriction demands a word of explanation. It is absolutely outside of the means that the

FIG. 4.—THE RAINBOW.

artist has at his disposal to represent the luminosity of various objects at its true *value*. If at midday we pass from the street into a room whose blinds are closed, we think that we are in complete darkness, and yet, in an instant, light reappears. If, afterward, we traverse a passageway completely closed, and lighted by a lamp only, we perceive a new fall of light. Now, if the artist wished to represent, in relative values, the street at noon and the aspects of the interior, in giving the first picture the greatest luminosity at his disposal, the two last would be of a deep black, with the exception of the little spot formed by the flame of the lamp.

Mr. Helmholtz cites conclusive examples of this principle. The ratio between the light of the sun and that of the moon is about 800,000 to 1. The reflecting power of lampblack is about 100 times less than that of white paper, and, consequently, the latter, illuminated by the moon, is 8,000 times less luminous than lampblack exposed to the sun. But the sensitiveness of our eye varies in such a measure that, in the least light, white paper will appear blue to us, while lampblack will always appear dark to us. This is not all; in the same picture, the parts near a luminous shore are darkened by contrast, and *vice versa*. The artist should inspire himself with this principle rather than with that of the relative luminosities, and, in fact, we should not be shocked on seeing, one alongside of the other, the three pictures just spoken of, painted in such tones that the first is not dazzling and the others are perfectly visible. We shall figure to ourselves solely that, in passing from one picture to the other, the sensitiveness of our eye will be modified. Although physically less accurate, the representation will be much more real.

But we may go still farther. White paper, illuminated by the sun, is 100,000 times less luminous than the disk of the star. Now, if the artist only takes care to give the sun a brilliancy three or four times greater than that of all the other parts of the picture, we shall declare ourselves satisfied. The reflecting power of the moon is scarcely more than a fifth of that of pure white. Consequently, if the sun and moon are simultaneously in the heavens, they will have a luster in the ratio of 500 000 to 1. The spectator is very indulgent under such a ratio, for he would feel much annoyed if the sun dazzled his eyes. The facilities that the good will of our visual organ accords to artists should not be carried too far, however. Although the examples of it are not rare, it is difficult to admit that the sun is less luminous than various parts of the picture.

Guillaumet, in his admirable picture of the desert (Luxembourg Museum), so full of warm light, has solved all the difficulties of relative luminosities by a stroke of genius, a genuine *tour de force*, but which would lose all of its value were it too often repeated. The sun is concealed by a caravan outlined against an extraordinarily luminous sky.

Let us pass to the geometry of pictures. Light is propagated in a straight line in a homogeneous medium, and the angle of incidence is equal to the angle of reflection—two laws that are known to every one, but which are often transgressed. Let us in the first place, from the double standpoint of geometry and light, examine Rubens' celebrated painting of Christ on the Cross (Museum of the Louvre). The figures in the foreground are brilliantly lighted from above, while a dull red star is disappearing in the background behind thick clouds. It appears evident that this star is no other than the darkened sun of St. Luke (xxiii. 45). But whence comes the mysterious light of the foreground, which nothing in the Gospels themselves authorizes us to admit?

Physics and geometry, strictly applied, would therefore decide against the artist. But he has not pretended to work according to nature, nor to offer an exact copy of a real landscape: and the hardened physicist, seeking in this shock to natural laws an occasion to criticise this magisterial and poignant work, would give proof of incurable pedantry.

In return, an error of optics in a study from nature constitutes an inexcusable defect. A small picture of Van der Neer's, "A Dutch Village" (Museum of the Louvre), gives us an example of this, among many others. The spectator perceives the moon (Fig. 1) about disappearing behind the roof of a house, in front of which there is a pool of water. We vaguely distinguish the inverted image of the building, and, just at the edge of it, a bright reflection of the moon, a little less apparent, however, than it is in our figure. Now let us establish the optics of the picture by a section of the landscape at right angles with the canvas (Fig. 2). The moon is totally concealed from the pool of water, and the point, L, where the image of the tree is visible to the spectator, O, can be perceived only from a point of the heavens very remote from the star. We may here see the danger of an after-touching.

Such an error is doubtless due to that too simple a rule given for the drawing of images upon a plane mirror; the image reproduces the object symmetrically with respect to the mirror. This principle, which is true objectively, ceases to be so in perspective, and the grossest errors are committed by the application of it. It would be impossible to give a better rule to the painter who, for want of time, has been unable to finish the image of a landscape in a sheet of water, than to make a rapid sketch in section of the opposite bank, and then apply the laws of reflection.

*The Rainbow.*—When a child, I often wished that I was in a rainbow, entirely surrounded by its beautiful colors. But it was in vain that I awaited the rainstorms of the setting sun and ran to the spot where I was certain I should see the extremity of the bow touch the earth; it always fled before me. Later on, I understood the reason of these repeated failures: A rainbow does not exist in a definite place; it is everywhere and nowhere and every one sees his particular rainbow, which shines for him alone around an axis passing through his eye and the sun placed behind him. Further, each of our eyes sees one, and the singular combination of these two different images contributes to give us, by the stereoscopic view that it engenders, an idea of the place where we imagine that we see it. To every spectator, a rainbow is always and necessarily circular, and if it occupies the center of a picture, the latter should be lighted in front by the sun. From this point of view, the beautiful painting of Spring, by Millet, recently acquired by the Museum of the Louvre, is absolutely perfect. In return, Mr. Norman Lockyer mentions various paintings in which the rainbow, doubtless portrayed after the cessation of the phenomenon, is visible along with the sun. In one of them even it is seen in perspective, that is to say, in the form of an ellipse.

One question of peculiar interest, even for the phy-

sicist, arises *apropos* of the rainbow, and that is, as to its image in water. We should here find, in an accurate painting, a flagrant violation, apparently, of the laws of reflection. In fact, the image of a rainbow is not symmetrical with the visible arch. The problem of the reflection of the arch, thoroughly elucidated by Mr. Henri Dufour, of Lausanne, can be treated in a few lines. In Fig. 3, the observer perceives the colors within a cone whose axis passes through the eye of the spectator and the sun, and the interior opening of which is about 40°, while the reflected arch is seen from points of the surface of the water for which the same condition is satisfied, and which, moreover, are so situated that the angle of incidence and the angle of reflection are identical to the observer. Let us draw through the eye of the observer a straight line, O B, symmetrical with O A with respect to the horizontal, O D. This line, reflected upon the water, indicates the direction, B C, of the arch visible through reflection, and whose image passes through $C^1$, symmetrical with C with respect to P. The reader will easily find the demonstration. As for the arch, A, itself, that could be reflected on the water only at the point, F.

The reflected arch is in the interior of the first, which it joins at the point of contact with the water. Fig. 4 represents a rainbow and what might be taken for its image, but which is symmetrical with the arch shown in dotted lines in the interior of the first. In the case supposed here we sometimes see other and very high arches produced by the dispersion of light previously reflected in the water.

If we consider, as we do in theory, a picture as an image projected upon canvas, and having to give an impression of reality to the spectator, the latter will be obliged to place himself at such a distance that the objects shall appear of true size at the place where the artist saw them. In most pictures in which perspective is not given by bodies geometrically regular (buildings, for example), there remains considerable indetermination as to the distance from which the spectator should view the canvas. However, in some very rare cases, such distance is absolutely fixed by a detail of the picture. A rainbow exactly determines the position of the spectator, who must be so situated as to see it perfectly circular and at a total interior angle of 80°.

*The Sun and the Moon.*—In the country and also in cities the moon is regarded with much suspicion, all sorts of bad intentions and inauspicious influences being attributed to it. Painters, on the contrary, are not sufficiently mistrustful of it, for it plays singular tricks on them. A reflection of this star has already permitted us to conclude that a small painting in the Louvre, which appears to be absolutely sincere, has received an after touching.

In the first place, the question of absolute dimensions is an important thing to be considered. The sun, like the moon, is seen from every part of the earth at a nearly constant angle of half a degree or of $\frac{1}{114}$. No painter has ever seen one of these stars at an angle sensibly different; they may therefore serve as a very accurate angle scale—in other words, they fix the position of the spectator with respect to the picture. Let us suppose that a painter represents Paris as seen from the heights of Saint Cloud. The Eiffel tower, situated at a distance of three and a half miles, will appear at an angle of $\frac{1}{70}$, and if the moon figures upon the same canvas, it should necessarily be from five to six times smaller than the tower. An American astronomer made a statement of the heights of various mountains that were represented as seen from a determinate place; a treacherous crescent moon often giving the scale of the picture, it was not difficult to measure the angle of vision, and to deduce the heights of the said mountains therefrom. All, without exception, were of an improbable height, one of them reaching 105 miles, or more than thirty-five times the height of Mont Blanc!

The Mole of Naples (Luxembourg Museum), one of the few pictures upon which we have been able to make accurate measurements, gives a very correct proportion between the setting sun and Vesuvius, seen from a distance of about seven miles.

The appearance of the moon, combined with its position with regard to the sun, is very little respected. We can see the full moon only in a place diametrically opposite the sun; a thin fillet of the moon, on the contrary, can be observed only in the immediate vicinity of the sun, whose position may frequently be accurately known by the lighting of the picture, even though the disk itself be invisible. It is not rare, however, to see a crescent hanging high in the heavens, although it is long after sunset. From this point of view, that calm, reposeful and luminous picture Space (Museum of the Louvre) contains a notable inaccuracy. All the shadows indicate a setting sun at right angles with the line of sight, while nearly opposite the spectator the full moon is rising. The two aspects are true, but they are evidently incompatible.

But worse still: In a picture of one of the last *Salons* the characteristic red of a sunset marks the place where the sun has just disappeared. High in the heavens, the moon directs its horns toward this place.*

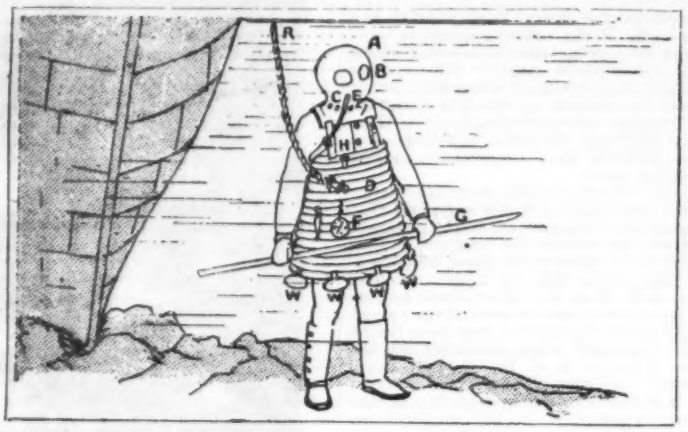
A young painter, to whom I imparted this observation, anwered me with charming candor: "What difference does that make, if the picture pleases the eye?"

I felt that we should never come to an agreement, and so I did not insist, seeing that the fatal *ne sutor ultra crepidam* was coming.

An anatomist would be listened to if he pointed out in a picture a monstrosity of his domain; and, further, no painter would expose himself to this sort of criticism, and would not venture to draw animals that were simply disproportionate; and yet physical monstrosities that no one will ever see, because they do not displease the eye, are admitted without the least hesitation.—*C. E. Guillaume, in La Nature.*

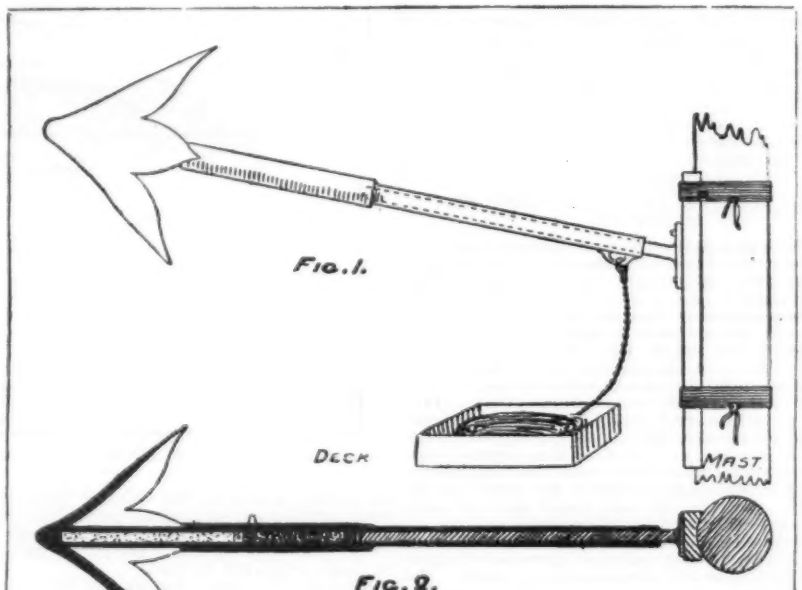
## LIFE SAVING DEVICES.†

THE competition has given rise to some very curious suggestions. One of these was that a flock of ducks should be carried on board ship and sent ashore with a line in case of wreck. Carrying a line ashore by means of sea gulls, pigeons, etc., is a common suggestion of competitors. Mr. A. W. Bevis' invention consists of a diving dress "which is easily and quickly put on, and is self-contained, needing no pumping arrangements on board." It is shown in the sketch. A is a helmet of sheet copper which fits down to the shoulders. It has air holes, C, all round the neck, and a glass lookout at B. D is a coil of steel pipes filled with compressed air. The upper end is left open and enters the helmet at E by a small India rubber pipe. H is a screw cock; W are weights; at F are a knife and compass; G is an iron rod. The diver is let down from the wreck by the rope, R. Having turned on the tap the helmet fills with air, and the surplus passes out of the air holes, C. "Thus the pressure in the helmet is always equal to the pressure due to the depth of water the wearer is in. Having safely landed at the bottom he makes his way, directed by the compass, to the nearest shore. As he nears shallow water he will have hard work against the waves, but our sailors are generally strong men, and by the aid of the staff and the weights to keep him from floating off his feet I believe he will be a master for them."




A SCHEME FOR WALKING ASHORE. (A design by Mr. A. W. Bevis.)

The sketches below illustrate what may be termed a rocket grapnel for establishing communication between a stranded ship and the shore. As may be seen from Fig. 1, which gives a general view of the apparatus, it consists of a fluke grapnel affixed to the head of a tube or gun barrel, which is partly charged with two explosives, an ordinary rocket charge and a charge of gunpowder. The only extra requirements are a short bar of iron affixed to a piece of wood, and a light, strong line. This piece of wood, with the bar, is then lashed to one of the masts, the tube slid upon the bar, and then fired by means of the fuse, which explodes the charge of powder, and at the same time ignites the fuse to the rocket. The impetus given by the firing charge will then be assisted by the rocket, which will also mark its course, in the event of darkness, to those on shore, if any one is there. The grapnel will readily take the beach, and so allow a man to pass along the line to the shore. The man will afterward haul a stouter line ashore, and thus establish a communication.



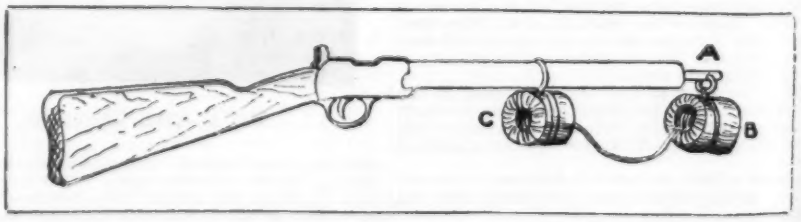

A ROCKET GRAPNEL. (From the designs of Mr. Thomas A. Jopling.)

Mr. Peter Poupard is full of ideas on the subject of life saving. He sends us several. One is a suggested united lifeboat service to ships in distress near land. It is on the principle that unity is strength. Thus, "a lifeboat started from shore and another put off from the stormbound vessel, both carrying cable (lead line), would only have half distance to travel. When near enough, line to be united, which would act as safety line to promote rescue." Another idea is expressed as follows: "Dogs, the friends of man, and especially when in trouble, could be trained to carry rope. The St. Bernard has been trained for work, and can do and endure what man could not. Why should not dogs be trained for this water service? If not live dogs, electrical dogs."

The following remarks by an experienced seaman, Captain Wallace McKendick, should be of interest, and even use, to those who have not yet sent in designs. He says:

"As a constant reader and a retired master mariner, I have taken a great interest in your 'Ship and Shore' competition, knowing as I do the necessity of some efficient communication. But I must protest against some of the suggestions which have been published. Surely the enterprising inventors have never seen a ship on a lee shore on a dark night, or they would never send such rubbish to be laughed at. I do not want to cast a slur on the designers of the apparatus, etc., but I think they ought to make themselves fully acquainted with the subject before sending their designs. The chances against submarine communication are so great that it ought to be abandoned."

For the purposes of their invention, Messrs. Rayner & Michell employ an ordinary breech-loading smooth bore gun, similar to a duck gun, but preferably having a shorter barrel. The gun is loaded with a metallic case cartridge containing a charge of powder. Down the barrel they place an iron rod, having a butt end to receive the force of the explosion. The length of the




A GUN WITH DOUBLE COIL OF LIFE LINE. (Designed by Messrs. Rayner and Michell.)

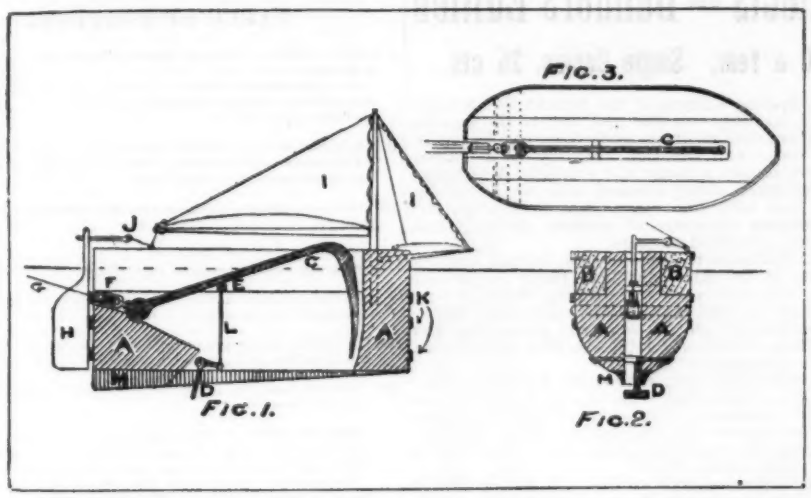
* This is not an uncommon error in paintings and engravings.

† Continued from SUPPLEMENT, No. 868, page 13865.

rod permits its other end to project a few inches beyond the muzzle of the barrel. This outer end of the rod is furnished with an eye or other suitable means by which is firmly secured to the rod a ball of tolerably strong line, such as cod line. The line pays out without friction from the interior of the ball or coil, which is wound similarly to an ordinary ball of string. A second and similar ball or coil of line is securely attached to the underside of the gun barrel, and the free ends of both balls are knotted together, or the balls may be wound from the same length of line. On the gun being discharged the rod is shot in any desired direction, carrying with it its ball of line which pays out in transit, and simultaneously the ball on the barrel pays out should the velocity of the rod demand it, so that friction, the inventors say, is reduced to a minimum, and there is no possible danger of the line being broken. A fuse is attached to the lower end of the rod, which gives out a stream of sparks as it flies along.

In the sketches of Mr. George Oyston's invention, Fig. 1 is the longitudinal section; Fig. 2 transverse section; Fig. 3 plan. The references are A A A A, solid wood; BB, cork; C, drop anchor; D, iron lever; E, wooden supports to anchor; F, pulley; G, line to ship; H, rudder; II, sails; J, self-steering tiller; K, iron bands; L, wire or chain; M, lead keel. The inventor says the two leading points of his design are direct communication with the shore and sufficient anchorage to hold a rope whereby a cradle may be sent ashore. The men have only to drop the apparatus overboard, and as soon as it gets the wind it will, he says, sail straight for the shore. Attached to it would be a line, which would be run out by those on board the stranded vessel, and as soon as the apparatus had touched the shore the anchor would get hold. They could then let out the rope, to which about six feet of chain would be attached. This chain is so arranged as to become firm in the block. This being fixed in, they could run the cradle ashore with a man in it, who could place the anchor in a stronger position if necessary. The first thing to touch the ground would be the lever, which, being pressed back, would pull down the chain or wire, which in turn would pull back a bolt and open the bar upon which the anchor rests, and the anchor would go down. The block would have a catch rounded at the end so as not to cut or grip either rope or line, but only to grip the chain by entering one of the links, and so prevent any slipping back.

A gentleman who signs himself "Arcturus" sends us a design for what he calls the "Flying Fish" anchor. It consists of a hollow tube similar to a torpedo, and constructed of steel of three-sixteenths inch thickness, having a grapnel or fin stiffened by "gusset" plates at each side. It also has a grapnel or fin at the bottom toward the smaller end of the tube, which acts to a certain extent as a rudder as well as ballast, that keeping the tube upright when in the water. On the upper side, above the water line, is a cone-shaped sail attachment of light sheet metal or canvas, supported on three light steel plates, radiating from the body of the tube. The center plate is extended further along the tube than the side plates for the purpose of keeping the tube "dead" before the wind. There are two small holes at the forward end of the cone to allow a small portion of the wind to pass through. The action of the wind upon the inside of the cone will have a tendency to lift the body and propel it before the wind toward the shore. At the smaller end of the tube is a swivel for attaching the whip or hawser. The inventor claims for it that when thrown overboard it will go direct to leeward, and when stranded will hold its own, without the aid of any assistance from the shore, and be able to effect communication from the ship to the shore by means of the whip line or hawser attached, in a manner similar to the rocket apparatus in use round our coasts.




A SAILING BOAT WITH ANCHOR. (From sketches by Mr. George Oyston.)

## LARROQUE'S EXPERIMENT.*

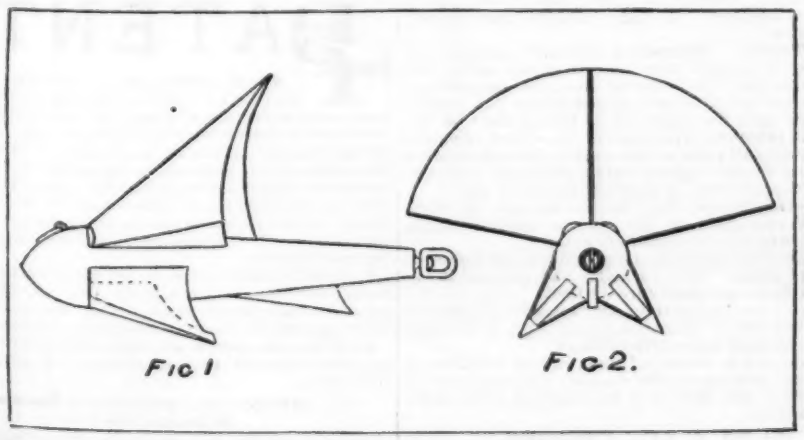
THE origin of local thunder storms in summer may be thus explained: In any region strongly heated by the sun's rays there arises an active evaporation, and in consequence a strong ascending current of air saturated with watery vapor. On entering the higher and colder regions of the atmosphere the watery vapor is condensed, and the heat thus liberated accelerates the upward current. The small drops are rapidly borne upward to a considerable height, and as a result of friction become charged with positive electricity, while the surroundings are negatively electric. The ascent of the water drops continues until their weight is sufficient to overcome the pressure of the ascending current of air.

As this process is continuous for long periods, the frequently great number of lightning discharges is not to be wondered at. It may also be remarked that Hoppe's hypothesis, that the planting of forests would tend to moderate electric conditions, is borne out by Bezold's observations, that deforested or swampy lands are most favorable to the generation of electric disturbances. In the first place, the forest shelters the floor from the sun's rays, arrests the evaporation due to a heated surface, and, consequently, the formation of ascending currents of vapor-laden air, which are precisely the phenomena which the conditions of deforested or swampy lands are designed to promote.

A reconciliation between the respective followers of the evaporation and frictional theories has been effected by Firmin Larroque through his recently published experiments. He points out that, in order to trace atmospheric electricity to its source, it is useless to speculate on whether it would be generated by the evaporation of pure distilled water carefully guarded from friction. There is nothing like this in nature to investigate; our proper course is rather to study evaporation under the conditions most nearly resembling those which attend the process of evaporation in nature.

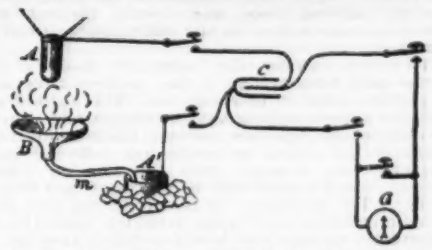
In so far as concerns the surface of the dry land, the surface water penetrates to a greater or less extent into the subsoil strata. Similarly the strata are penetrated by the warmth of the sun's rays. It follows, then, that in notably damp earth vapor is formed, not merely at the earth's surface, but also at greater or less depths below it, and cannot escape into the air until after its passage through strata of prescribed thickness. One need hardly remark that in this way the vapor has abundant opportunity for friction. And here two possibilities have to be kept in mind: (1) The evaporation of water follows as a simple consequence of a pure mechanical separation of the water from neutral earthy substances; or (2) of a separation of the water from chemical combinations. It is consequently a matter for experiment whether the vapor thus evolved is electric or not.

* Der Stein der Weisen, Vienna.




THE "FLYING FISH" ANCHOR. (Designed by "Arcturus.")

Larroque's experimental appliances are illustrated in the accompanying figure. A is an insulated pendent platina vessel filled with ice or water at 1 or 2° Cent. B represents an insulated glass evaporating vessel. The heating of this pan, usually to 30° C., is provided for by any source of heat the rays of which are thrown by a reflector on B. This pan is provided below with a sort of pipe attachment through which, by means of a cork, the cotton wick, *m*, is introduced. Inside the pan, the wick end is drawn up, while the other end extends to the platina vessel, A', which is




LARROQUE'S EXPERIMENTAL APPARATUS.

kept cool by ice or cold water, whichever is employed in A. The wick, *m*, is saturated with pure distilled water, of which a few drops are conveyed to the vessel, A', to maintain the continuity of the circuit. A and A' are respectively provided with keyed wire connections leading to the condenser, C. The condenser attachments, on the other hand, are attached to the supports of a galvanometer, G. By this arrangement there is no need to fear that the experiment will be influenced by any deposition of water from the surrounding atmosphere, for this vapor would be precipitated at A under precisely the same conditions as at A'; hence A and A' would at the most be laden with electricity of equal power. The condenser, C, would receive a like current of electricity from both, and, in consequence, as is well known, could not be charged. Instead, vapor would be first disengaged from the pan, B, after which the condenser could be charged with electricity.

The first series of investigations on these lines were confined to evaporation from mechanical admixtures. To this end the pan, B, was filled with neutral substances, such as powdered brick, glass, broken marble, granite, sand, etc., saturated with distilled water. Only brick and granite gave positive results. With these the galvanometer indicated from 1 to 2 millimeters, and rendered the condensed vapor recognizable as positively electric. The indication of the galvanometer, in fact, increased to 5 millimeters when the moist brick mass in pan B was heated to 60°.

Still more decisive results were secured by the evaporation of water from chemical combinations. For example, the employment of common, in the place of the distilled water, and heating to 30°, caused the galvanometer to indicate 6 millimeters. If sea water was employed, the condenser was so strongly charged that it was not safe to discharge it in full force through the galvanometer without interrupting the observation. The charge was, therefore, reduced one-half by the interpolation of a subsidiary condenser. Nevertheless, Larroque obtained discharges up to 37 millimeters. The electricity of the condensed vapor showed itself positive. In fact, the watery vapor separated from almost all earthy substances showed itself positive. Mixed sands and clays gave the best results. The galvanometer indicated from 15 to 39 millimeters without any weakening of the condenser charge.

Larroque, therefore, holds it demonstrated by these experiments that water liberated by evaporation from chemical combinations is electric; that water evaporated from the ocean is equally electric, and that the vapors from this source are, ordinarily, positively electric.—*Electrical Age.*

## THE EFFECTS OF AN AURORAL DISTURBANCE ON CABLES AND LAND LINES.

THE New York *Sun* says that the remarkable auroral disturbance on July 16 produced curious phenomena on the telegraph circuits and instruments of submarine cables and aerial land lines that may afford data for scientific men in determining the actual nature and laws of the mysterious auroral phenomenon itself. In a broad sense telegraphic circuits are affected by auroral displays in the same manner as by violent thunder storms, but the precise effects from the two causes are very different. Interruptions to telegraphic communications on lines in far northern latitudes are of frequent occurrence. The lines in Canada, for instance, which run north of Lake Superior, from Montreal to Winnipeg, are at certain seasons of the year interrupted almost nightly by slight auroral disturbances. But the disturbance on July 16 was the most remarkable in its effects on telegraph circuits of any noted for a great many years, if not the greatest of all such displays. A prominent electrician in this city took careful note and tests of the effects of this disturbance, and he calculated that the force of the electrical current from the auroral disturbance was equal to 500 volts.

It is interesting to note, too, that the telegraph instruments showed the auroral disturbance to be very much greater during the day, from about 11 in the morning to 4 in the afternoon, our time, when there was no spectacular display of celestial scenic effects, than it was at night when the wonderful phenomenon was so apparent. The electrical disturbances were noted at precisely the same time in this city, in Chicago, and in Nova Scotia and Newfoundland. In Chicago it was noted that, while the sky was cloudless and the sun was shining brightly, tremendous currents of electricity charged the air, completely interrupting all telegraphic communication. The currents came in waves at irregular intervals.

But the most interesting effects were noted on the delicate instruments of the Atlantic cables, and with these, on account of their peculiar construction, various phenomena of the auroral disturbance could be noted that were not possible on land line instruments. With the latter the effect was simply to put a

current or a ground on the circuit, which broke things up generally and prevented all communication. On the cable instruments the length, intensity, and direction of the waves of electricity were recorded accurately. The effects were noted on the instruments of the cables that run into this city from Nova Scotia, and on the long cables at Nova Scotia and Newfoundland, which run under the Atlantic to Ireland. It was on the long cables that the auroral effects were displayed most strongly, and as the cable drops directly from the office into the ocean, and lies at the bottom in some places three miles down, the presumption that the auroral force was exerted through that watery space as well as on the instruments directly is of interest.

The siphon recorder, the instrument used for submarine cable telegraphing, is the most sensitive kind of galvanometer in practical use. The auroral disturbance interrupted communication entirely. During the disturbance, especially between the hours of 11 and 3 midday, the siphon or needle was deflected intermittently very strongly from the zero, or middle position, and it swayed first to the right and then to the left. The movement of the needle was very slow. It would suddenly move away to the left, pulled by say a northerly current, and would be pulled very far, indeed, beyond the limit of any cable current, indicating that the current was very powerful. It would remain at the extreme point of deflection from 5 to 10 or 15 seconds, and then return slowly to zero. Sometimes immediately, sometimes a few seconds or minutes later, the needle would be pulled slowly in the other direction by a southerly current, would deflect to a remarkable distance, remain there a few seconds, and then return slowly to zero. That seemed to indicate that the electrical currents set up by the aurora were very powerful, were steady and of long duration, and alternated in direction of force in their polarity; they were like great waves of the ocean ebbing and flowing. The effect of a severe thunder storm on a cable instrument, felt often when the storm is far at sea, is a quick, instantaneous jerk of the siphon, the effect lasting only an instant. The cables were affected in the evening of the auroral display when the heavens were aglow with the magnificent streamers and banners of light, but the interruption was very slight as compared with that experienced during the day.

## WEIGHING PRECIPITATES UPON DRIED FILTERS.

By FR. RUDORFF.

THE author uses a filter extracted with hydrochloric and hydrofluoric acids. He places such a filter in a small cylindrical glass with a cap ground to fit. He uses glasses of 75 mm. in height and 34 mm. in diameter. The glass with the filter is placed in a drying closet previously heated to the required temperature, the cap of the glass having been laid upon the closet. After the lapse of thirty minutes the glass is taken out and the cap is immediately applied. The closed glass is then allowed to cool without the use of the exsiccator for thirty minutes, the last ten of which are passed in the balance case; it is then weighed. The precipitate is then filtered off, and washed and dried at 100° on the funnel in a drying closet. The filter with the precipitate is then placed in the weighing glass and exposed for thirty minutes to the same temperature as the filter has been previously. The glass is taken out of the drying closet, immediately closed with its lid, and weighed after having been exposed to the air for exactly thirty minutes. The chief point is that the cooling process must last exactly thirty minutes, the last ten minutes in the balance case.—*Zeit. fur Angew. Chemie.*

## RESIDUAL LIFE OF MUSCLE.

By ARM. GAUTIER and L. LANDI.

THE authors have already shown that the effect of the anaerobic life of the muscular tissue is to acidify and peptonize a small proportion of its proteic substances. A part of the myoalbumen is changed into caseine and into various leucomaines. The fats do not vary appreciably. No glucose can be found in preserved meat, and the glycogen has completely disappeared, being, in the opinion of the authors, partially converted into carbonic acid and alcohol, both of which have been demonstrated. Urea is not produced in any proportion in preserved meat and ammonia, and its salts do not appear in quantities of any importance. Meats if preserved from atmospheric microbia are incapable of undergoing spontaneously the ureic or ammoniacal fermentation. Hence the anaerobic fermentations which occur in muscular tissue free from microbia differ profoundly from the bacterian fermentations essentially hydrating and ammoniacal. The gases emitted by 100 grammes of meat kept for six days at 39° were found to be:

| | |
|---|---|
| $CO_2$ | 27·5 c. c. |
| N | 1·1 " |
| H | 4·7 " |

The easy production of hydrobilirubine in the economy as soon as boron sets in; the reduction of indigo blue and purple in our organs; the property which muscular flesh possesses of transforming by mere contact and in the cold a small but constant quantity of free sulphur into hydrogen sulphide, shows in what a state of instability is a small portion of the hydrogen which enters into the constitution of the immediate principles of muscle and of its protoplasms. The authors proceed to describe the physiological action of the bases extracted from the muscular tissue.

## A NEW SILVER ORE.

By H. N. WARREN, Research Analyst.

THE locality known as Broken Hill, in Australia, has to all interested in mining operations been recognized from an early period as a vast silver region, and the author has on numerous occasions had attention directed to such minerals as fahlerz, polybasite, horn silver, etc., derived from the above locality, and which from assay of the same have proved themselves valuable metallurgical products. Besides these argentiferous formations there is, however, situated in the same locality immense argillaceous deposits, consisting for the most part of ordinary kaolin.

These deposits have for years been regarded as a waste product on account of the numerous hard particles of horny substance disseminated throughout its structure, thus rendering it unfit for porcelain or other manufacture. The mass of kaolin, as far as can be ascertained, thus remained untouched until the commencement of the present year, when it was again overhauled by some traveling mineralogists, who, on applying a few physical tests, such as ascertaining the hardness of the particles, etc., at once became struck with their appearance and resemblance to horn silver, and being thus induced to proceed to practical tests, in so doing verifying their supposed theory, the common kaolin deposits at once foreshadow one of the richest silver harvests yet to be gleaned.

I have assayed quite recently a number of samples since the discovery of the same, and find in some the existence of silver iodide only, in others chloride only, while in further specimens the existence of both chloride, bromide and iodide—the percentage of silver averaging from 7 to 10 per cent., with traces of gold; while in other cases samples weighing upward of 20 lb. in weight of pure chloride have been obtained.—*Chemical News.*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